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EPA

Coalbed Methane Recovery and Electric Power Generation Project

Opportunity at the Wesola Mine Myslowice, Poland

EPA

COALBED METHANE OUTREACH PROGRAM

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Opportunity at the Wesola Mine
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Coalbed Methane Outreach Program
Atmospheric Pollution Prevention Division
U.S. Environmental Protection Agency

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UNITS AND MEASUREMENTS

CO	Carbon monoxide
CO_2	Carbon dioxide
G	Giga
GJ	Giga joule
H_2	Hydrogen gas
He	Helium
kg	Kilogram
kJ	Kilo joule
kN	Kilo Newton
kW-hr	Kilowatt hour
$M	Million dollars
m	Meter
m^3	Cubic meter
md	Milli-darcy
mm	Millimeter
m/s	Meters per second
MPa	Mega Pascal
M tonnes	Million metric tons
MW	Megawatt
MWth	Megawatts, thermal
MWe	Megawatts, electric
$N \cdot m$	Newton meters
NO_x	Nitrogen oxides
PM	Particulate matter
rpm	Revolutions per minute
SO_2	Sulfur dioxide
t	Metric ton, 1,000 kilograms
Tonne	Metric ton, 1,000 kilograms

ACRONYMS

ECP	Engineering Procurement and Construction
U.S. EPA	U.S. Environmental Protection Agency
IRR	Internal Rate of Return
NPV	Net Present Value
ROM	Run of Mine
USB	Upper Silesian Basin
$US	U.S. Dollars
VAT	Value Added Tax
ZEC	Zaklad Energetyki Cieplnej
ZOK	Zaklad Odemeanowania Kopaln Spolka ZO.O.

1.0 PROJECT PRESENTATION

This U.S. Environmental Protection Agency (U.S. EPA) report is a prefeasibility assessment of an opportunity to establish two modern coal mine methane technologies at gassy underground coal mines in the Upper Silesian Basin (USB), Poland. The first is the use of directional drilling tools to develop horizontal gob boreholes to drain methane more efficiently than conventional methods. The second is the introduction of a gas turbine cogeneration plant fueled with coal mine methane that produces both electric power and heat. A demonstration project combining both techniques would be located at the Wesola Mine, a property of the Katowice Holding Company which owns ten other coal mines in the USB.

Ideas for technology transfers and eventual selection of the Wesola Mine arose from two U.S. EPA missions, one in 1995 and the other in 1997. During the second mission, U.S. EPA and U.S. and Polish contractors performed research to investigate the technical, institutional, and economic feasibility of the proposed project, and they narrowed the selection of a project site to Wesola.

Poland is a large producer of underground coal. Many of its coals are gassy (i.e., above 8.0 cubic meters (m^3) per tonne of coal in situ). Although many Polish mines recover and use significant amounts of methane, they encounter difficulty in reducing coal mine methane emissions, partly due to the lack of capital and partly due to uncertainty of the effectiveness of available technologies. Much of Poland's coal industry loses money due to over-capacity, over-employment, and difficult geological conditions. The new Polish government, which took over in November of 1997, intends to restructure the coal industry. Restructuring will pressure all coal companies to modernize and control costs to increase the probability of survival. The Polish coal mining status, therefore, creates a receptive climate for the introduction of the improved methods described herein. A successful implementation of this and similar projects in the USB also will benefit the global climate by substantially reducing the quantity of methane emitted to the atmosphere.

1.1 Project Description

The project is comprised of two components: directional drilling and power and heat generation.

1.1.1 Drilling Project

The Wesola Mine, located in northeastern USB in the town of Myslowice, presently produces approximately 3.5 million metric tons (M tonnes) of coal per year. Wesola continuously searches for ways to reduce mining and degasification costs and to increase coal production. This will become even more important as it exploits even deeper levels where refrigeration of mine ventilation air may be required. Wesola management is receptive to the project.

The mine relies on a system of overlying galleries for stress relief, gob degasification, and for application (injection) of backfilling material. Wesola engineers indicate that new techniques are needed for continued and profitable exploitation of new sections of the mine. If they can achieve effective gob degasification with in-mine horizontal gob boreholes and minimize overlying galleries, they can reduce development costs.

Horizontal gob boreholes are small (76 to 90 millimeter (mm) in diameter), long (in excess of 1,000 m) boreholes developed from the mining horizon up into strata overlying unmined panels.

Through the use of directional drilling tools, these boreholes strategically intersect fractures that will generate over the rubble zone after undermining by longwall systems. The technique takes advantage of the large surface area presented by the horizontal borehole which provides excellent connectivity with these mining-induced fractures.

Horizontal gob borehole development requires state-of-the-art, in-mine directional drilling equipment. Japanese and Chinese coal operations use the technique, and U.S. mines have conducted field trials. It is suitable for deployment in deeper, multi-seam operations. Miners have found that horizontal gob boreholes provide high degasification efficiencies at lower costs than either boreholes drilled from overlying galleries, or cross-measure boreholes (angled boreholes drilled in advance of mining into overlying or underlying strata from gate entries) The technique requires fewer boreholes and is applicable to both advancing or retreat longwall systems.

The drilling equipment for the Wesola project will cost approximately US$1.6 million, including import fees, equipment approval, and training costs. Implementing horizontal gob boreholes at the Wesola Mine will reduce gob degasification costs, improve current gob gas recovery efficiencies, and increase recovered gas quality. More importantly with respect to the mine's economic results, the method will improve mining productivity. Any improvement to degasification efficiency will reduce the frequent down times attributed to high methane concentrations at the mine's working faces. Wesola presently encounters mine-wide methane production delays that significantly reduce coal production.

The project described herein will purchase the drilling equipment and operate it in the Wesola Mine as well as in other gassy mines in the USB, particularly those that use the overlying gallery degasification system. Drainage engineers familiar with the Basin indicate that the new drill will have extensive application, especially at mines that exploit shallower reserves, and where the vertical distances between mined seams are greater. Unlike Wesola, these operations would be less prone to adverse stress conditions and could have more success in avoiding the use of overlying galleries.

1.1.2 Gas Turbine Power Cogeneration Facility

The second part of the project is a 2.5 megawatt electric (MWe) gas turbine facility that uses all of the methane drained by the mine, supplemented with fumigant methane contained in the mine's ventilation exhaust which serves as the turbine combustion intake air. The facility will generate both power and heat. With improved methane drainage techniques, the mine can supply sufficient gas to increase the plant output with a second turbine unit.

Commercial turbines modified to operate on medium quality gas (as low as 35 percent methane in air) are available and are in use at a few coal mining operations in Germany (Kowollik and Heimer, 1986). The use of mine ventilation exhaust air as combustion air is currently demonstrated at two multi-unit, coal mine methane-fueled, internal combustion engine power plants in Australia.

The estimated capital cost of the power and heat generation facility is approximately US$3.0 million including shipping and import taxes. Project development and construction costs are US$280,000. The proposed project will provide more efficient use of the drained methane gas and provide cost benefits to both the Wesola Mine and the affiliated energy company Zaklad Energetyki Cieplnej (ZEC).

1.2 Anticipated Participants

The 1997 U.S. EPA mission held discussions with several existing entities that may play a role in the development of this project. There are at least two other entities, as yet non-existent or unidentified, that are necessary to implement the project: the project entity and the project developer. Both are discussed in the next section. The following paragraphs identify existing participants.

1.2.1 Katowice Holding Company

Katowice Holding owns the Wesola Mine and an operating subsidiary, Zaklad Energetyki Cieplnej (ZEC), described below. The company maintains decision making authority over potential ventures entered into by its subsidiaries.

1.2.2 Wesola Mine

The mine is the project host, the gas supplier, and the purchaser of drilling and energy services and products. From this influential position, the mine must take an important role in the project. On the other hand, the mine may not wish to absorb the project into its current financial difficulties by being the sole project owner.

1.2.3 ZEC

ZEC, a subsidiary of Katowice Holding, is currently Wesola's coal mine methane customer and supplier of heat. The project must fit within that relationship.

1.2.4 ZOK

Zaklad Odemeanowania Kopaln Spolka Zo.o., (ZOK), is the established methane drainage service company (consulting and drilling) in the region.

1.3 Proposed Project Structure

A project structure is the arrangement of project ownership and financing which is supported by contractual agreements. The structure recognizes "senior money" (i.e., low-risk equity capital), and it provides rewards to the high-risk development capital. The structure allows vested interests (e.g., the Wesola Mine), to obtain a share of the project in consideration for in-kind services such as a free ground lease and long-term contracts. A project of this type normally uses a project entity, created only for the project (see below). Such a project also requires a developer who will accept an ownership share in return for services.

1.3.1 Developer

While the report does not identify a specific developer, it defines developer roles and ideal characteristics.

A developer takes many coordinated steps to build a viable project vehicle that is sustained by a network of contractual agreements and a flow of funds that are sufficient to reward every participant. Normally the developer's role continues until closing, after which the developer may assume another project role or turn the project management over to the project entity. A developer will, either personally or by contract, arrange all project matters: technical, legal, financial, and environmental. A motivated developer linked with a well-financed entity with access to capital is best able to sustain all project demands until closing. An ideal developer will be willing to assume project risks and will receive rewards only after the project achieves success.

1.3.2 Project Entity

Most energy projects, especially those with complex ownership, choose to create a new corporation or other limited-liability, legal entity to create and embody the ownership and management of the project. The entity is empowered to raise money, make contracts, hire contractors and personnel, and operate the business. The entity's rights and duties are described in the contracts drawn up by the developer and the project owners. This report recommends that the project entity be separate from the Wesola Mine, although it may be appropriate to include the mine as a minor shareholder.

1.3.3 Ownership Options

Ownership shares of the proposed drilling and power generation project at the Wesola Mine may accrue to entities that have benefited the project in one of three ways:

- Time and effort—"sweat equity"—and deferred payment (e.g., the developer, equipment supplier (ABB), or an ECP Contractor).

- In-kind services or items of value (e.g., site lease and services from Wesola, engineering services from ZEC and ZOK, and driller training costs and assistance with equipment approval from ZOK).

- Equity capital (cash). Equity providers will have the strongest claim on ownership of the project.

1.4 Proposed Financing Sources

The total estimated project costs (see Table 3.1) are approximately US$4.95 million in hard costs and US$0.13 million in in-kind contributions. The 1997 U.S. EPA mission interviewed a number of private and public sources of financing including grant funds, equity contributions, and debt capital. Many of the respondents advised that this project obtain a 40 percent equity share, including potential grant funds. The following are proposed sources of financing for the project. Information on other potential sources appears in Attachments 10 and 11.

- ECOFUND can provide grant funds up to 30 percent of the investment value. Attachment 12 reviews the origin of this agency.

- The National Fund and its local associates, the Voivodship Funds (see Attachment 13) provide grants, cash equity (National Fund), and debt (with remission provisions). Fines and fees paid by mining and industrial operations support the National Fund. These funds can provide up to 20 percent of the equity capital and 30 percent of debt financing.

- Commercial banks provide up to 30 percent of debt financing (see Attachments 10 and 11).

- The economic analyses in this report assumed the following sources of equity and debt capital:

		Percent	US$M
Equity			
	ECOFUND (Grant)	20	.99
	National Fund	10	.50
	Private Sources and Project Development	10	.50
	Total Equity	**40**	**1.99**
Debt			
	National Fund/Voivodship Fund	30	1.48
	Commercial Banks	30	1.48
	Total Debt	**60**	**2.96**
	Total Capitalization (cash)	**100**	**4.95**

1.5 Profit Results

Table 4.3 in Section 4 presents the financial results of the project, given various sensitivity conditions. The analyses specifically define prices for energy and drilling services bought and sold between the project entity and its major participants. To be conservative, the analysis causes the project to pay at current market levels, but to sell at prices favorable to both Wesola and ZEC.

The project likely qualifies for a grant from ECOFUND for 20 percent of the capital cost. All of the cases with an ECOFUND grant show that the project will earn 15 percent or higher internal rate of return (IRR), after tax. Without the grant, the project earns marginal after-tax IRR's of between 5 and 10 percent for the range of sensitivity conditions investigated.

Based on assumptions developed in Section 3 and summarized above, the financial analyses indicate that the power, heat, and drilling project at the Wesola Mine is economically viable. The sensitivity studies show that the project is marginal without the ECOFUND grant and with power and heat prices that are very favorable to the Wesola Mine and ZEC. These prices will be necessary to interest the Wesola Mine and ZEC, as both of these entities are key to the proposed project. The ECOFUND grant is necessary to more easily attract commercial and private debt and equity sources, and to increase the likelihood of project development.

1.6 Project Benefits and Risks

1.6.1 Benefits

The proposed project, more than being a viable business enterprise, will provide a wide range of benefits to the mine, ZEC, the USB coal mine industry, and the global environment. The benefits are listed below and described more fully in Section 5.

1.6.1.1 Wesola Mine

- Power cost savings
- Increased revenues from gas sales
- Reduced degasification costs
- Increased revenues from increased coal production
- Operational benefits
- Reduced environmental fees (potential)

1.6.1.2 ZEC

- No loss of current market
- Increased profit margins

1.6.1.3 Upper Silesian Coal Basin Coal Mining Industry

- Introduces new, more effective drilling method to the region
- Provides training and new business opportunity to ZOK (or new business entity)
- Adds potential markets for USB coal mine methane
- Contributes to the competitiveness of USB coal mining

1.6.1.4 Environment

- Removes the methane global warming equivalent of approximately 630,000 tonnes of carbon dioxide (CO_2) through the course of the project period
- Offsets 9,135 tonnes of coal annually, mitigating an additional 18,108 tonnes of CO_2 per year
- Improves local air quality (nitrogen oxide (NO_X), sulfur dioxide (SO_2), and particulate matter (PM) reductions)

1.6.2 Risks

Project developers, debt, and equity providers can minimize project risks by performing due diligence to give the assurance that the project has no fundamental flaws, and that all uncertainties have been resolved. The perceived risks and uncertainties of the proposed project are listed below and described in Section 5.

1.6.2.1 Permitting Risk

- Timing of approval of drilling equipment by Polish Higher Mining Authority

1.6.2.2 Financing Risk

- Ability to assemble a cohesive group of investors and lenders
- Agreement on a project structure, distribution of equity, dividend and payout schedules

1.6.2.3 Gas Risk

- Securing a predictable supply of CMM
- Ensuring continued methane drainage activities at Wesola

1.6.2.4 Construction Risks

- Controlling costs and construction delays

1.6.2.5 Market Risk

- Establishing firm, "Take-or-Pay" power and heat contracts

1.6.2.6 Mine Closing Risk

- Assuring continued mine operation, considering financial status of coal sector in Poland

1.6.2.7 Technical Risk

- Ensuring smooth functioning of project systems

1.7 Wesola Mine General Information

1.7.1 Background

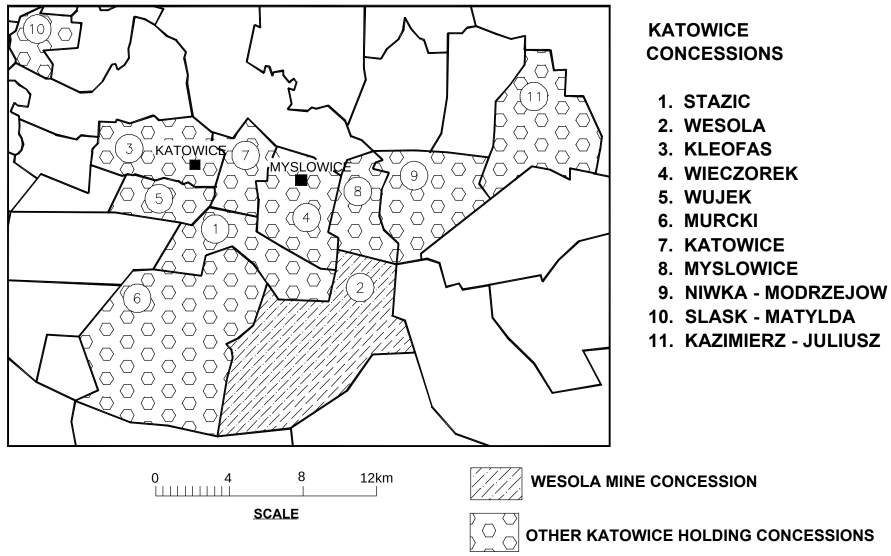
The Wesola Mine is located in the northeastern portion of the Upper Silesian Coal Basin (USB), in the town of Myslowice, southeast of Katowice. The Wesola Mine is one of eleven mines that comprise the state-owned Katowice Holding Company as shown on Figure 1.1. Mine development began in the early 1950s on a concession that occupies approximately 45 km^2. The mine employs about 5,500 people in the region.

1.7.2 Description of Business

The Wesola Mine, owned by the Katowice Holding Company along with 10 other coal mines, is one of Katowice Holding's largest coal producers and largest employers. The Wesola Mine presently produces approximately 3.5 M tonnes of sub-bituminous through high-volatile bituminous coal per year, from six or more working levels. The mine holds significant coal and methane reserves. The concession contains over 1,000 M tonnes of measured and indicated coal reserves. In-situ methane resources associated with these coal reserves exceed 11.0 G cubic meters.

Wesola is continuously working to implement techniques to reduce mining and degasification costs and increase coal production. It is planning to exploit even deeper levels where refrigeration of mine ventilation air may be required.

The Wesola Mine staff supports the project proposed herein because of the mine's large power demand and its high cost of mining, exacerbated by extensive degasification and consolidation (backfilling) programs.



SOURCE: BUREAU OF GEOLOGIC CONCESSIONS

Figure 1.1: Location of the Wesola Mine Concession in Upper Silesia

1.7.3 Wesola Mine Production History

The Wesola Mine's coal production decreased to the 3.5 M tonnes per year level in 1990 as developments moved to deeper levels. Previously, the mine produced about 5.5 M tonnes per year on a relatively consistent basis between 1980 and 1990. Coal production at Wesola started in 1952.

1.7.4 Current Financial History of the Mine

According to the latest available financial information, the Wesola Mine is not a profitable operation. 1993 financial information indicates that the mine's operating costs exceeded revenues from coal sales by US$21 million (Nasz Holding, 1994).

1.7.5 Wesola's Role in the Coal Industry

Poland's coal industry continues to lose economic ground. Efforts at accepting an industry-wide restructuring plan failed in 1996 despite an influx of consulting assistance from the European Union and the U.S. Trade and Development Agency. Recent elections in September of 1997 yielded a new government controlled by the AWS Party. The new government, including the other major political faction (the Freedom Union), has plans to restructure the coal industry. Major changes are planned, including a 30 M tonnes per year reduction in coal production, and a 70,000 personnel labor reduction by the year 2000. Restructuring will pressure the Katowice Holding Company to modernize and control costs at their most viable properties to increase the probability of survival.

1.7.6 Level of Technical Sophistication and Capability

As discussed above, the Wesola Mine's engineering and management staff supports the proposed project and foresees the need to implement new technology to compete and operate profitably in a freer market. Wesola's engineering staff is extensive (a chief engineer with subordinate engineering support staff for every discipline), educated, and very capable of incorporating and adapting new technology into their mining programs.

2.0 TECHNICAL DISCUSSION OF GOB GAS RECOVERY AND POWER GENERATION PROJECT

2.1 Mine Site Characteristics

2.1.1 Geologic Conditions

In the USB, two distinct formations comprise the coal bearing strata: an upper formation of continental sediments, and a lower formation of siliciclastic sediments. These formations bear 234 coal seams, averaging 339 meters (m) in total thickness, of which 200 are economic for mining based on Polish estimates and conditions.

In the vicinity of the Wesola Mine (the central part of the USB), triassic and tertiary formations (composed of claystones, sandstones, dolomites, limestones, shales, conglomerates, and mudstones) overlie the carboniferous formations (tertiary lies unconformably). At the Wesola Mine, the immediate overburden is not impermeable. Initially methane content increases with increased depth, then, at a point through the coal bearing strata, a distinct reduction with depth is observed.

Presently the mine produces coal from six sub-bituminous through high volatile, B, bituminous in rank, coal seams with an average heating value of 23,545 kilo joule per kilo gram (kJ/kg): the No. 405, 401, 501, 510, 414, and 314. Immediate mine plans (next 5 years), focus on exploiting the very gassy 501 and 510 coal seams, which have a combined thickness of 8.6 m. A binder that varies between one and 25 meters in thickness separates these two seams across the property.

2.1.2 Coal Reservoir Characteristics

2.1.2.1 In-Situ Gas Content

Desorption measurements conducted on coals from the Wesola Mine using the Polish canister method indicate in-situ gas contents of up to 11.6 m^3 per tonne (U.S. EPA, 1995). Polish Methane Hazard Classification information indicates that the majority of the coal seams presently mined at Wesola have in-situ gas contents greater than 8.0 m^3 per tonne. By the year 2005, in excess of 60 percent of coal production will originate from coals with this magnitude of gas content or greater.

2.1.2.2 Permeability

Absolute permeabilities of coals in the USB typically range between 0.1 and 1.0 milli-darcy (md). Mining operations exploiting gas-bearing strata with these characteristically low permeability values lend themselves to degasification techniques applied immediately in advance of mining (short boreholes from coal faces to intersect fissures), and focusing on gob gas emissions. In longwall gobs, overlying strata will fracture extensively as a result of mining activity, and permeability will increase by several orders of magnitude.

2.1.2.3 Gas Quality

The Wesola Mine recovers a methane and air mixture from gob areas; approximately 60 percent methane and 40 percent air on a volume basis. Generally, coalbed gas recovered from virgin coals in the USB contains a high percentage of nitrogen (average between 15 and 17 percent), along with lower concentrations of CO_2, CO, H_2 and He (Polish Geologic Institute, 1994).

2.1.2.4 Mine Characteristics

The Wesola Mine exploits the six coal seams identified above with longwall mining methods. Seven longwall faces operate at different levels, with personnel, materials, and ventilation supplied via six shafts. The mine presently (as of 1997) produces in excess of 3.5 M tonnes of coal per year from depths greater than 850 m below surface. Measured and indicated coal reserves are in excess of 1,000 M tonnes (U.S. EPA, 1995). The anticipated life of the mine is more than 20 years.

2.1.2.5 Methane Emissions

Wesola personnel indicate that methane emissions during longwall mining of some of the gassier seams, (longwall 1016a in the 501 seam for example) are in excess of 39 m^3 per minute. These emissions contribute to the present total mine methane liberation rate of between 105,000 and 140,000 m^3 per day (123,000 m^3 per day average for 1996). Figure 2.1 illustrates mine methane emissions by month for 1996. Wesola mining engineers anticipate that annual mine methane liberations will increase by approximately 10 percent by the year 2000 and will level off thereafter (see Figure 2.6).

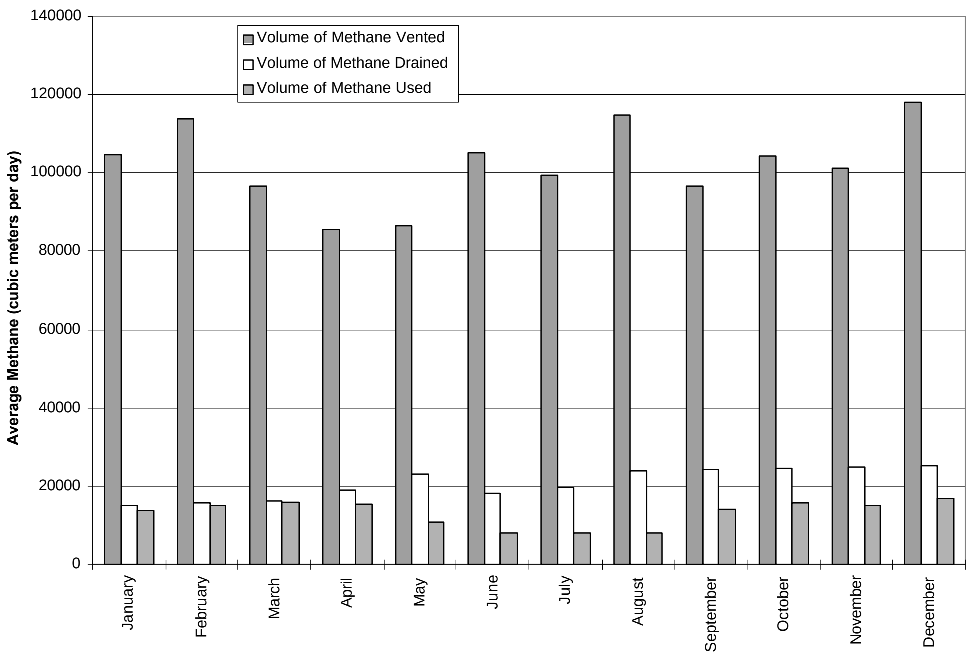


Figure 2.1: Wesola Mine 1996 Methane Vented, Drained, and Used

2.1.2.6 Mine Degasification

The Wesola Mine uses various degasification techniques, including short-probe boreholes developed immediately in advance of mining, cross-measure boreholes, and boreholes drilled from gob gas drainage galleries.

As indicated on Figure 2.1, the Wesola Mine degasification system recovers between 12 and 21 percent of the methane liberated, or between 15,000 and 25,000 m^3 per day (17 percent average degasification system efficiency for 1996). Mine accounting reports indicate that overall degasification costs, which include the costs of materials, salaries to workers, and energy for both surface and underground related activities, exceed US$800,000 per year.

2.1.2.7 Methane Utilization

The Wesola Mine operates a surface methane drainage plant equipped with seven vacuum pumps, with a total production capacity of 86,400 m^3 of methane per day. The plant is situated on the surface at one of the mine's ventilation exhaust shafts (the "Waclaw" Shaft). The plant presently operates at approximately 25 percent of capacity and currently processes gas of between 55 and 65 percent methane in air on a volume basis (61 percent 1996 average). As indicated on Figure 2.1, the mine uses most of the gas drained during the winter but less than 40 percent of the drained gas during summer months (65 percent 1996 overall average use). The gas is sold to Zaklad Energetyki Cieplnej (ZEC), which operates two boiler houses: a small facility capable of producing approximately 1.4 megawatt of thermal energy (MWth), and a larger 30 MWth facility. As the boilers are fitted with over-stoke burners, ZEC has the option to fuel them with either gas or coal.

The Wesola Mine purchases more than 50 percent of the annual heat generated by ZEC for hot water heating and building heating (average of 58 percent of ZEC heat for 1996). ZEC sells the balance of the heat to the local district heating network.

2.1.3 Current Mining and Gob Degasification Plan

The Wesola Mine's near-term plans focus on exploitation of the 501 and 510 coal seams (Saddle Group), in the northern part of the concession in areas designated as B and D. In this region, the two target seams remain relatively close to each other (1 m in some places), with the 501 seam at the higher elevation. The mine exploits these seams using a retreat system of single entry longwall panels, each capable of producing in excess of 4,000 tonnes of coal per day.

In mining the Saddle Group, the mine relies on a system of overlying galleries for stress relief, gob degasification, and for application of backfilling material. Wesola engineers indicate that because of their multi-level mining program, especially in areas where the mined seams are in close proximity to each other, extensive consolidation of the longwall gob is necessary to minimize roof control problems and stress conditions. For the initial longwalls in the saddle group, Wesola operators developed overlying galleries in the uneconomic 416 coal seam, approximately 40 m above the 501. As operators developed subsequent panels they determined that this seam is not contiguous and resorted to developing overlying galleries in rock. For some panels, operators were able to use existing galleries at higher levels.

Wesola personnel indicate that new degasification techniques are needed for continued exploitation of the Saddle Group, and that these techniques must consider stress relief conditions and gob consolidation requirements.

2.1.3.1 Degasification from Overlying Galleries in the Saddle Group

The mine utilizes galleries as platforms from which it develops angled gob boreholes into the strata overlying the 501 seam as shown generally on Figure 2.2. Methane emissions and the degasification effectiveness attained by Wesola with the overlying gallery system of degasification, as measured for one of the gassiest longwalls in the Saddle Group to date, are shown on Figure 2.3. The magnitude of these emissions, in connection with projected increases in coal production from the Saddle Group, demonstrates the urgency of Wesola's degasification needs.

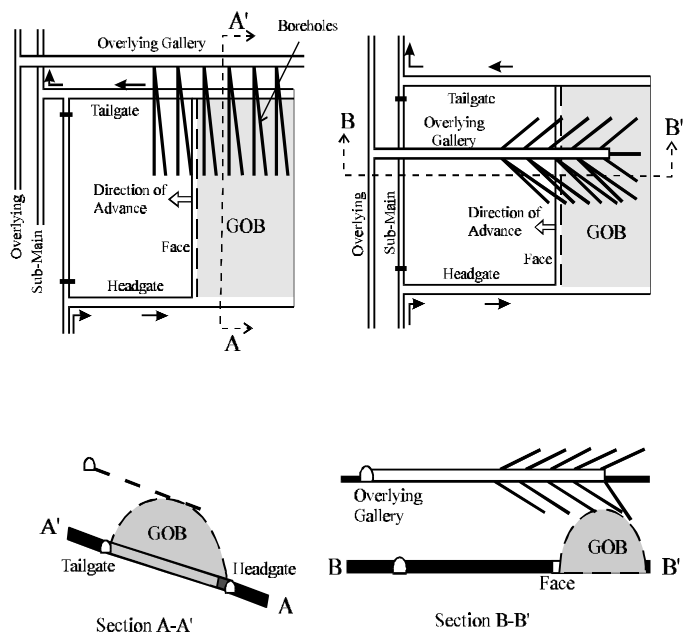


Figure 2.2: Gob Degasification from Overlying Galleries

Moreover, Wesola reports extensive lost time delays during mining because of high methane concentrations in the ventilating air stream at the working faces (up to 7,320 minutes per month, mine-wide for all working sections).

2.1.3.2 Cost of Degasification from Overlying Galleries in the Saddle Group

Wesola Mine engineers indicate that if effective gob degasification could be achieved without

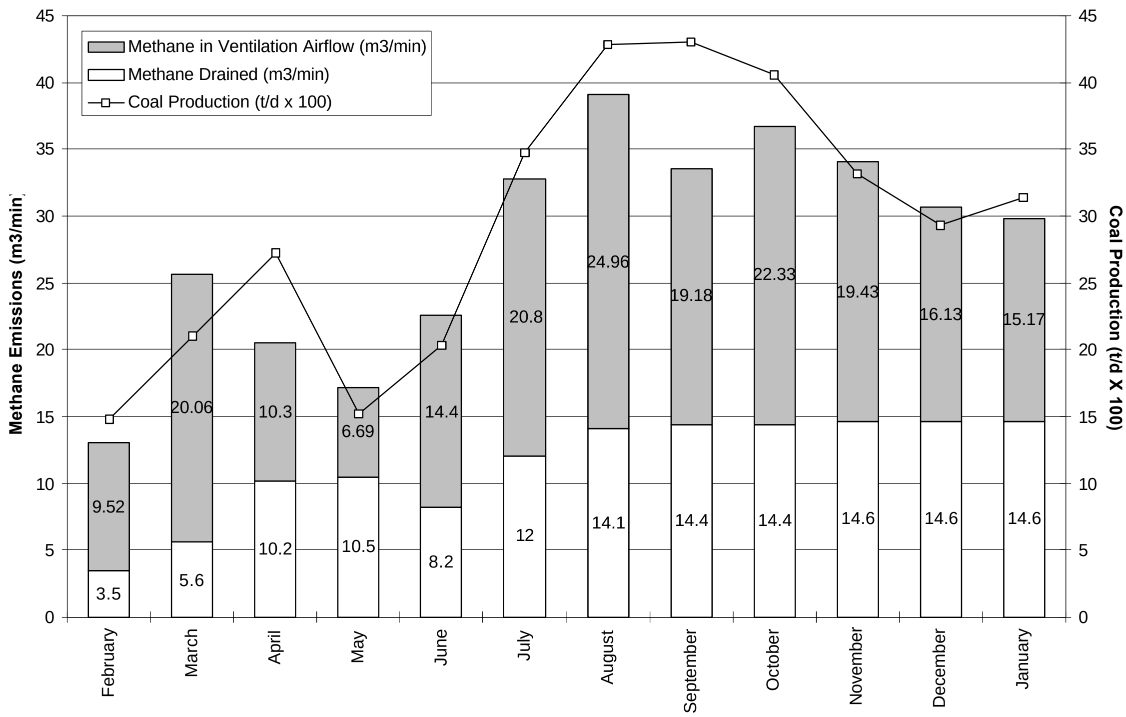


Figure 2.3: Coal Production and Methane Emissions from Longwall 1016a in the 501 Coal Seam

overlying galleries (e.g., by using in-mine horizontal gob boreholes) they could minimize development of this costly infrastructure. They indicate that this is particularly valid in the Saddle Group areas where the galleries would need to be driven in rock; specifically in the B area where the 416 seam is discontinuous. Table 2.1 presents an estimate of the costs incurred by Wesola for incorporating the overlying gallery degasification technique, including the cost of developing the galleries, drilling the gob boreholes, installing the gathering lines, and maintaining the system. Cost calculations using Wesola Mine data are included in Attachment 1.

Component	Cost in US $1,000's
1250 Meters of Gallery	900
60 Boreholes	224
Gathering Lines and Wellheads	21
System Maintenance	15
Total Per Longwall Panel	1,160

Table 2.1: Cost of Gob Degasification with Overlying Galleries Per Longwall

2.2 The Horizontal Gob Borehole Approach

Wesola Mine personnel are receptive to the horizontal gob borehole approach to reduce the development of galleries constructed in the 416 seam or in rock for degasification purposes. As previously mentioned, horizontal gob boreholes are small diameter (76 to 90 mm), long (in excess of 1,000 m) boreholes developed from the mining horizon up into strata overlying unmined panels as shown on Figure 2.4 (boreholes are drilled from entry on left side of figure).

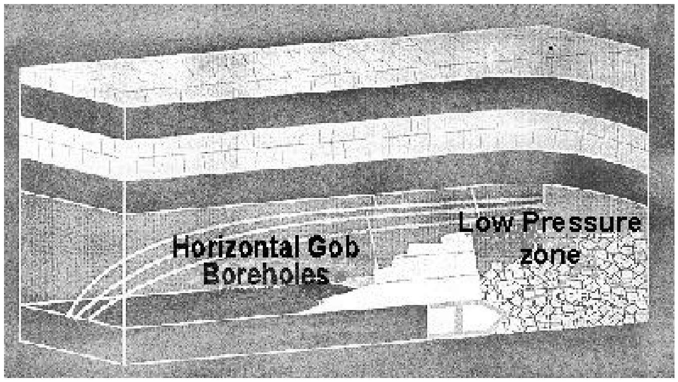


Figure 2.4: Horizontal Gob Boreholes

These boreholes are developed in advance of mining with directional drilling equipment to strategically intersect fractures that will generate over the rubble zone after undermining by longwall systems. The large surface area presented by the horizontal borehole provides excellent connectivity with these mining-induced fractures in the relaxed zone over the gob area.

This horizontal gob borehole technique is applied in coal operations in Japan and in China where the United Nations administered a technology transfer program, and it has been field tested in the United States (see Attachment 2 for results of United States field trials). It is suitable for deployment in deeper, multi-seam operations where the more common gob degasification techniques are cross-measure or overlying gallery methods. Miners have found that this technique provides high degasification efficiencies at lower implementation costs than either the overlying gallery or the cross-measure methods. This unique technique requires a reduced number of boreholes and applies to both advancing or retreating longwall systems.

2.2.1 Equipment Requirements

Horizontal gob borehole development requires state-of-the-art, permissible, in-mine directional drilling equipment comprised of: a high thrust permissible drill, a steerable downhole motor assembly, drill rods, drill bits, and a survey system. Figure 2.5 shows a typical high-capacity, permissible drilling system comprised of a drill and support unit. The support unit provides hydraulic power for drill thrust and controls, and pressurized water for downhole motor operations. All drill operations, except tramming (electric), are hydraulic powered. Table 2.2 presents general specifications of a high-capacity longhole drill and tender. Attachment 3 presents detailed descriptions of downhole equipment for directional drilling.

High Capacity Longhole Drill Specifications	
Drill Unit Dimensions	2.083 m (W) X 1.092 m (H) X 3.835 m (L)
Weight of Drill Unit	9,080 kg
Maximum Thrust (Push and Pull)	178 kN
Maximum Torque	3391 N·m (at 100 rpm)
Maximum Stroke	3.35 m
Max Rated Drill Head Advance	0.25 m/s
Feed Frame Inclination	+/- 15 Degrees from Horizontal
Drill Chuck System	BQ - Size (56 mm Diameter)
High Capacity Longhole Drill Tender Specifications	
Tender Unit Dimensions	2.4 m (W) X 1.2 m (H) X 4.065 m (L)
Weight of Tender Unit	11,340 kg
Water Pumping System	3.9 l/sec and 8 MPa Maximum Rated
Monitoring	Methane /Fire Suppression

Table 2.2: High Capacity Longhole Drill and Tender Unit Specifications

2.2.2 Equipment Costs

Table 2.3 itemizes the drilling and ancillary equipment and procurement costs required for the development of horizontal gob degasification boreholes. These costs reflect United Kingdom mine equipment permissibility requirements (more stringent than in the Unites States), and assume that all of the equipment is imported to Poland from the United States, including shipping and import duties and taxes. Supplies sufficient to develop 1000 m boreholes are specified.

Description	Unit Price	Unit	Quantity	Total Cost
1. Longhole Directional Drill				
a. Drill and Power Unit	$650,000	Package	1	$650,000
1. Drill Rods				
a. Non-Magnetic Drill Rods	$500	Meter	40	$20,000
b. BQWL Drill Rods	$30	Meter	2,000	$60,000
c. Downhole Fishing Tools	$5,000	Package	3	$15,000
1. Downhole Motor				
a. 1-2 Stage “B” Motor	$19,000	Package	4	$76,000
b. Orientation Sub and Spare Subs	$2,500	Package	4	$10,000
c. Spare U-Joints and Bearings	$7,500	Package	4	$30,000
d. Fishing Tools	$2,000	Package	3	$6,000
1. Survey Tools				
a. Downhole Single Shot Tool	$22,500	Package	2	$45,000
b. Ancillary Equipment and Spare Parts	$5,000	Package	4	$20,000
1. Miscellaneous Items				
a. Drill Bits	$1,500	Per Unit	35	$52,500
b. Hole Openers	$750	Per Unit	6	$4,500
c. Miscellaneous	$3,000	Package	1	$3,000
1. Other				
a. Shipping and Insurance	$28,000	Quote	1	$28,000
b. Customs Duties	$204,000	20%	1	$204,000
c. Value Added Tax (VAT)	$85,680	7%	1	$85,680
			TOTAL	$1,309,680

Notes:
1. The border tax, former 5%, was eliminated.
2. Customs duties are an average 20% of value, inclusive of shipping for agro-industrial products.
3. Equipment is not subject to excise tax.
4. Equipment is subject to 7% VAT on customs value plus excise tax plus duty.

Table 2.3: Cost of Directional Drilling Equipment Imported to Poland

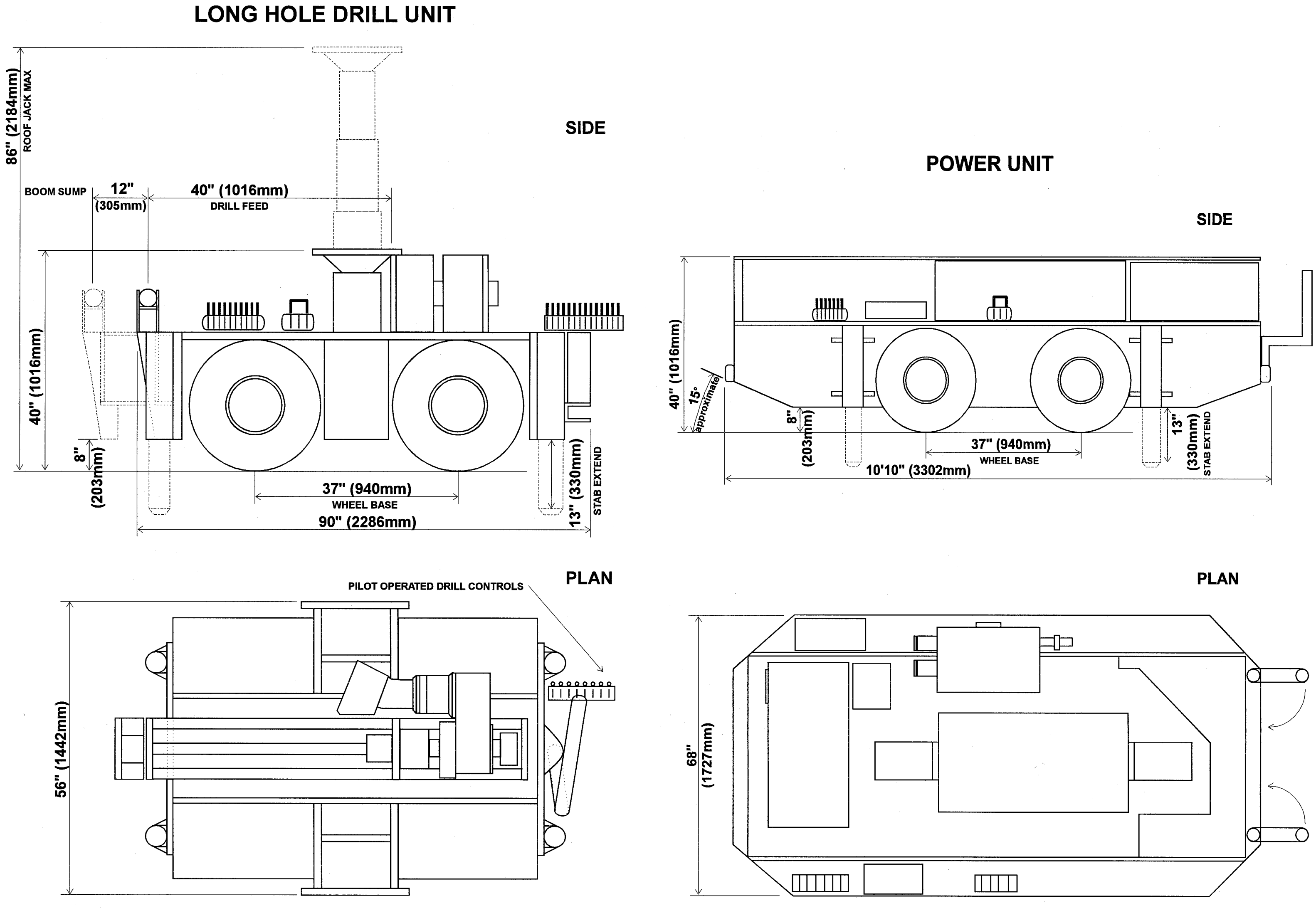


Figure 2.5: High Capacity Longhole Drill and Tender Unit

2.2.3 Application at Wesola

If planned in coordination with mine development and production efforts, horizontal gob boreholes can be successfully deployed at the Wesola Mine. This must be done with mine participation and must consider the prevalent geologic conditions at the proposed drilling locations, the mine's experience at drilling into overlying strata, and knowledge of the size and capabilities of the drilling equipment.

2.2.3.1 Drilling Locations

Wesola engineers indicate that horizontal gob boreholes are applicable for degasification of some longwall gobs in the Saddle Seams. They indicate that because of backfilling requirements and stress conditions, the horizontal gob boreholes will not replace all of the overlying gallery development, but would certainly reduce the extent of this costly infrastructure. The boreholes are especially applicable in the B and D Saddle Seam areas where some of the overlying galleries need to be developed in rock. Although difficult to assess without initial on-site trials of the technique, designers anticipate that approximately 30 percent of the gallery infrastructure could be negated by the use of horizontal gob boreholes in the Saddle Seam area.

Wesola engineers must plan a degasification system for each longwall panel according to Polish mining code. Their engineers use the consulting capabilities of ZOK for methane drainage planning and drilling. ZOK has over 30 years of degasification experience in the Upper Silesian Basin and should be involved in planning the drilling locations for the horizontal gob boreholes at Wesola.

Drill site selection will need to consider: (1) the required azimuth of the boreholes (relative to the longwall panel configuration), (2) the maximum attainable vertical borehole deflection rate, and (3) optimizing drilling efficiency by maximizing the number of boreholes developed from a single drill site (minimizing movement of drilling equipment). A preliminary review of mining plans indicates that approximately three horizontal gob borehole drilling sites and a total of nine horizontal gob boreholes are necessary to degasify the gobs of two longwall panels. This is a general requirement that will vary depending on the specifics of the mining plan and geologic conditions.

2.2.3.2 Application over Longwall Gobs

Wesola operators must develop a series of parallel horizontal boreholes with slightly overlapped zones of influence to achieve a broad, continuous low-pressure zone over the target longwall gob. They must target a region just below the lowest contributing source seam in the fractured zone above the gob (but above the rubble zone). Recommended targets include the tension zones at the start and ends, and along the sides, of longwall panels where strata are relaxed and the apertures of mining-induced fractures remain open. With directional drilling techniques, operators can develop a multitude of deviated, tangential boreholes from an original, single borehole once this borehole reaches the desired horizontal horizon.

2.2.3.3 Drilling Conditions

Wesola Mine personnel have experienced borehole stability problems when drilling into overlying strata from galleries in the northwest Saddle Seam area and attribute this to competent rock and adverse stress conditions relating to previous over-mining. In these conditions, the boreholes were sheared by discrete fracturing and in some cases did not produce any gas from the gob area after undermining.

When determining the required horizontal target and appropriate drilling procedures, Wesola and ZOK drilling experience will be invaluable.

2.2.3.4 Capabilities of the Drilling Equipment

Critical to this project is the maximum vertical deflection rate that the equipment and drilling tools attain from a set inclination at the drill site. These parameters for site selection and targeting assessments are needed. The directional drilling equipment presented herein can deflect vertically at a maximum rate of up to one degree within approximately three meters, depending upon the composition of the strata. The equipment can incline the drill feed frame 15 degrees from horizontal.

2.2.4 Directional Drilling Costs

To apply directional drilling technology at Wesola to develop horizontal gob boreholes, imported drilling equipment is required. It must be approved by the Polish Higher Mining Authority for use in Polish mines and Polish drilling technicians must be trained.

Estimated Costs for directional drilling to develop horizontal gob boreholes at Wesola assume that a trained third-party contractor (ZOK or new entity) performs the drilling on a cost-per-meter basis.

2.2.4.1 Polish Approval of Equipment

As per Polish Geological and Mining Law (Dziennik Ustaw Rzeczypospolieej Polskiej of 1994), No. 92, Item 34, underground drilling equipment must be approved by the President of the Higher Mining Authority in Katowice before it is used in Polish mines. For approval, an application must be filed with technical and safety specifications of the equipment for review by a research institute, and a fee must be paid to the Ministry of Finance. The institute may request that the applicant pay for research and testing. Attachment 4 presents details of the approval process, including contact information for the Polish Higher Mining Authority.

The specified permissible drilling equipment is to be built to United Kingdom coal mine permissibility standards. These meet the most stringent permissibility standards and will expedite the approval process (anticipated to be not more than three months). Estimated costs for approval of permissible drilling equipment are US$40,000.

2.2.4.2 Directional Drilling Training

Directional drilling training, involving initial classroom time along with field demonstrations (actually drilling from a site at the Wesola Mine), will be necessary. Classroom sessions will cover drill operation, borehole trajectory control, surveying, tool maintenance, trouble shooting, and system applications. Field training will involve an initial demonstration of directional drilling (one borehole would be drilled to completion), and subsequent active participation of Polish drilling personnel with supervision. This report estimates a two-man, three-month training effort totaling US$140,000, including other direct costs.

2.2.4.3 Horizontal Gob Borehole Development Costs

These costs include: (1) labor to develop the drilling site, (2) procurement and installation costs for the wellhead assembly, and (3) directional drilling costs, assuming a contractor is hired to case and drill three overlying horizontal gob boreholes from one drilling station. Directional drilling cost estimates use rates charged by contracting companies in the United States adjusted for differences in labor costs. Table 2.4 presents the costs to develop three horizontal gob boreholes from one drill site. Attachment 5 shows site development and drilling rate calculations.

Development Costs: 3 x 1000 m Horizontal Gob Borehole	
Component	**Cost (US$)**
Establish Drill Site	$10,250
Wellhead Equipment and Casing	$10,800
Borehole Drilling @ US$50 per m.	$150,000
Total Estimated Costs	$171,050

Table 2.4: Total Estimated Costs for Three Horizontal Gob Boreholes Developed by Drilling Contractor

As only a few boreholes are necessary per longwall panel with the horizontal gob borehole degasification program, relative to 60 with the overlying galleries, wellhead and gas collection system maintenance and inspection costs will be minimal.

2.2.5 Benefits of Horizontal Gob Boreholes at the Wesola Mine

Implementing horizontal gob boreholes at the Wesola Mine will reduce gob degasification system costs, improve current gob gas recovery efficiencies, improve mining productivity, and increase recovered gas quality. The economic impact of these improvements on Wesola Mine operations is estimated below.

2.2.5.1 Degasification System Cost Savings

Section 2.1.3.2 estimates the cost of implementing a gob degasification system from overlying galleries constructed specifically for that purpose. On a per longwall panel basis, that cost is approximately US$1.16 million. Assuming an average of three drill sites and three horizontal gob boreholes per drill site for two longwall panels, the development cost estimates for an equivalent horizontal gob borehole system are US$513,000 for two longwall panels, or US$256,000 per panel. This represents savings of US$904,000 per longwall panel if all of the overlying gallery requirements were avoided. Since Wesola may have to use some galleries for other purposes, as per Section 2.2.3, it may only avoid a portion of these developments. Table 2.5 projects savings at various levels of reduced requirements for galleries.

Reduction in Gallery Development per Panel (%)	Cost Savings US$1,000's per longwall panel
30	$274
40	$364
50	$454
60	$546
70	$634

Anticipated Gallery Reduction

Table 2.5: Projected Savings for Range of Gallery Development Avoided in the Saddle Area

2.2.5.2 Improved Methane Recovery

Operators can achieve reasonable methane capture efficiencies with the gallery system because galleries operate independently of mining activity, facilitating borehole placement and resulting in improved borehole integrity. Also, the proximity of the galleries to the gob simplifies borehole targeting. Wesola achieves efficiencies of approximately 40 percent (for longwall districts only, not mine-wide).

Factors that reduce methane capture and recovered gas quality at Wesola include system control and operation (e.g., coping with the large number of boreholes) concerns relating to spontaneous combustion, and the impacts of air intrusion through the gob.

Because substantially fewer boreholes are required with the horizontal gob borehole system, operators need to devote less effort to proper suction control and system inspection and maintenance. A properly implemented and operated horizontal gob borehole system increases methane recovery while allowing less air intrusion. Operators can achieve capture efficiencies of between 60 to 70 percent for longwall districts with this system.

The overall methane recovery efficiency at Wesola will increase with horizontal gob boreholes. The rate of increase will depend on implementation rate, application underground (because Wesola may need galleries in some areas), and emissions from coal faces and development sections (expected to increase as gassier coals are mined). This analysis derived two average methane recovery efficiency projections. The first assumes an increase in efficiency of 5 percent per year to achieve an average mine efficiency of 26 percent by the year 2005. The second assumes an aggressive 10 percent increase per year to achieve a mine recovery efficiency of 40 percent by 2005. The proposed drilling and power generation project considers the more conservative 5 percent per year schedule.

2.2.5.3 Increased Coal Production

At the Wesola Mine, any improvements to system capture efficiency reduces the frequent down times attributed to high methane concentrations at working faces. Wesola presently encounters mine-wide methane production delays of between 4,000 and 7,320 minutes over a one-month period. In gassy conditions, average daily longwall production is approximately 1,875 tonnes per day (2,900 tonnes per day average for Longwall 1016a), while under ideal conditions (no gas, geologic, or equipment delays), operators have achieved peak daily production rates of 3,500 to 4,000 tonnes per day. Table 2.6 projects annual revenue benefits to Wesola, per longwall panel, with improvements to district degasification system efficiency. This table assumes that Wesola could achieve, on average, 60 percent of ideal coal production rates (i.e., 2,400 tonnes per day per longwall), if gas delays were negated. The table further assumes that all gas delays are mitigated with a district degasification system efficiency of 60 percent (present district system efficiencies equal approximately 40 percent).

District Degasification Efficiency (%)	**Average Daily Coal Production per Longwall (t/d)**	**Projected Increase in Annual Coal Revenues US$1,000's per Panel***
40	1,875	$0
45	2,005	$624
50	2,135	$1,248
55	2,265	$1,872
60	2,400	$2,520

*Assumes 250 production days per year, and that clean coal is 80% of ROM, and US$24 per tonne coal.

Table 2.6: Projected Annual Revenue Gains for a Range of Degasification Improvement in the Saddle Area on a per Longwall Basis

2.2.5.4 Total Cost Advantage

Table 2.7 presents the potential total annual cost advantage of the horizontal gob boreholes relative to the gallery system for the range of coal production improvements and avoided gallery costs for a single longwall in the Saddle Area.

	Reduction in Gallery Development (%)				
Degasification Efficiency (%)	**30**	**40**	**50**	**60**	**70**
40	$161	$228	$302	$390	$477
45	$785	$852	$926	$1,014	$1,101
50	$1,409	$1,476	$1,550	$1,638	$1,725
55	$2,033	$2,100	$2,174	$2,262	$2,349
60	$2,681	$2,748	$2,822	$2,910	$2,997

Anticipated Gallery Reduction

Table 2.7: Projected Total Annual Cost Benefit (US$1,000's) for Range of Avoided Gallery Development and Degasification Improvement in the Saddle Area on a per Longwall Basis

2.2.6 Application at Other Mines in the Upper Silesian Coal Basin

Coal operators at other gassy mines in the Upper Silesian Coal Basin use the overlying gallery system of longwall gob degasification, specifically: Nadwislanska Spokla Weglowa S.A.'s Brezeszcze and Silesia Mines, Katowice Holding Company's neighboring Staszic Mine, and Jastrzebska Spokla Weglowa S.A.'s Morcinek and Krupinski Mines. Drainage engineers familiar with the mining conditions in the Basin indicate that horizontal gob boreholes will likely replace overlying degasification galleries at mines that exploit shallower reserves, and where vertical distances between mined seams are greater. These operations would be less prone to adverse stress conditions and will not require overlying galleries for injection of backfill materials.

2.3 Proposed Gas Turbine Power Generation Facility

The project proposed herein considers a gas turbine facility that uses all of the methane drained from the mine, supplemented with methane, in concentrations of less than one percent, from the mine's ventilation exhaust shaft (used as combustion intake air), to generate both power and heat. The proposed project would provide more efficient use of the drained methane gas and provide cost benefits to both the Wesola Mine and ZEC.

2.3.1 Methane from Wesola's Drainage Plant

As shown on Figure 2.1, the Wesola Mine presently recovers between 12,000 and 25,000 m^3 of coal mine methane per day as a mixture of methane and air (on average 61 percent methane on a volume basis). As presented in Section 2.1.2.7, the mine sells on average, 65 percent of this gas to ZEC to fuel mine-site boilers; the unused gas vents to the atmosphere. The mine sells the drained methane for US$0.022 per cubic meter of methane, which in 1996, generated revenues of approximately US$106,000.

The volume of methane drained per day by Wesola is sufficient to fuel a gas turbine generating between 2.0 and 2.5 MWe, depending on efficiency. The mine anticipates that methane emissions will increase by 10 percent by the year 2000, and then remain relatively constant through the year 2005. They expect to produce coal at decreased rates from increasingly gassier seams (60 percent of seams mined in 2005 are expected to have in-situ gas contents of greater than 8 m^3 per tonne). With improved methane drainage techniques and higher degasification system efficiencies, the mine could supply sufficient gas to generate up to 4 MWe. Figure 2.6 presents projected methane emissions and drainage volumes (with the 5 and 10 percent per year improved drainage efficiency schedules) for the next ten years.

2.3.2 Wesola Mine Power / Heat Demands and Costs

2.3.2.1 Power

The Wesola Mine uses over 150,000 MW-h and pays over US$6 million per year for power. Their power purchase contract is similar in structure to those negotiated in the United States where the mine pays a monthly demand charge (for 32 MW), a premium for 15-minute peak demand per month on a MW basis, and consumption charges depending on time of use (peak AM, peak PM, and night). Figure 2.7 presents the monthly costs of power for each of the cost components in the purchase agreement for 1996.

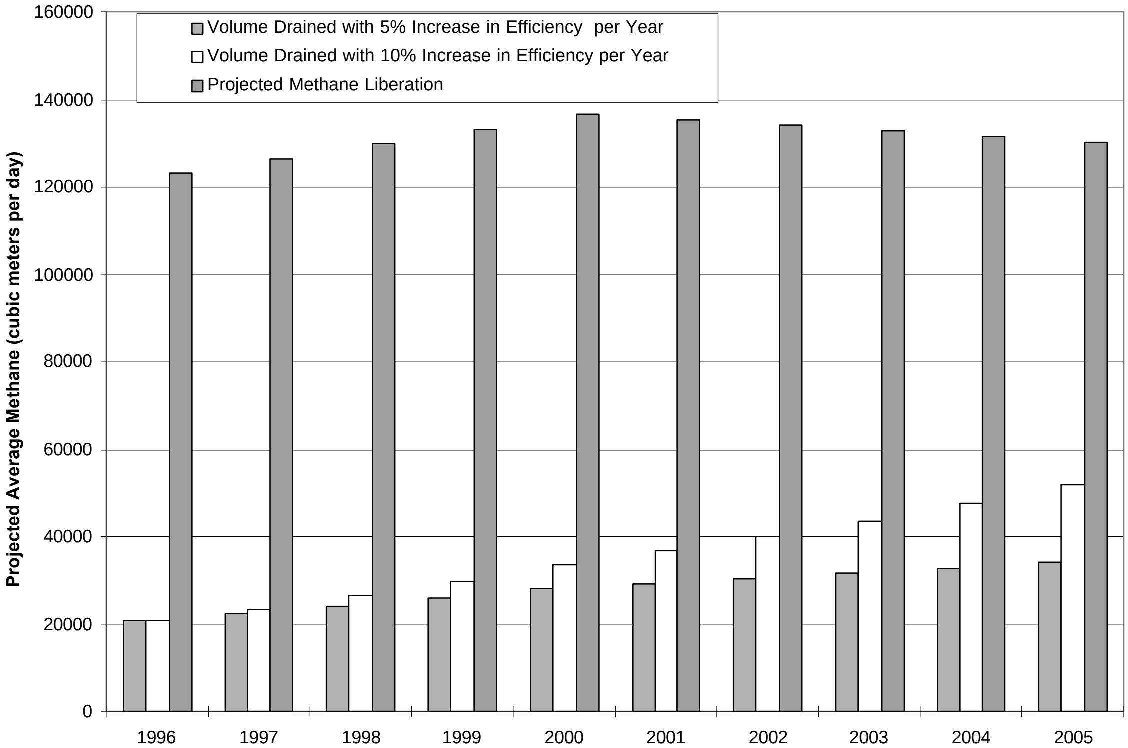


Figure 2.6: Projected Methane Liberations and Methane Drained with Improved Degasification Efficiency (5 and 10% Increase per year after 1996)

The Wesola Mine's time-weighted average cost of consumed power (energy, not demand) for 1996 is US$0.031 per kilowatt hour (kW-hr). Accounting for demand charges, Wesola pays an average total cost of power of US$0.038 on a kW-hr consumed basis. A detailed presentation of power demand and consumption costs is presented in Attachment 7.

Wesola management anticipates that the mine's power demand will gradually increase over the next 10 years as ventilation demands and haul distances increase; they anticipate a 2.7 MW increase in 15-minute peak demand power between 1996 and 2005. Improved degasification efficiencies will reduce this projection.

2.3.2.3 Heat

The Wesola Mine purchases heat from ZEC at an average price of US$4.85 per giga joule (GJ). In 1996, the mine purchased over 250,000 GJ (for US$1.2 million). Peak mine heat demands in winter exceed 18 MWth, while summer demands decrease to approximately 2 MWth.

Mine engineers indicate that an additional 2 to 6 MWth could be used for operation of absorption chillers to satisfy future underground mine refrigeration requirements. Wesola engineers anticipate refrigerating the mine's ventilation air at deeper levels where they expect virgin rock temperatures exceeding 40°C.

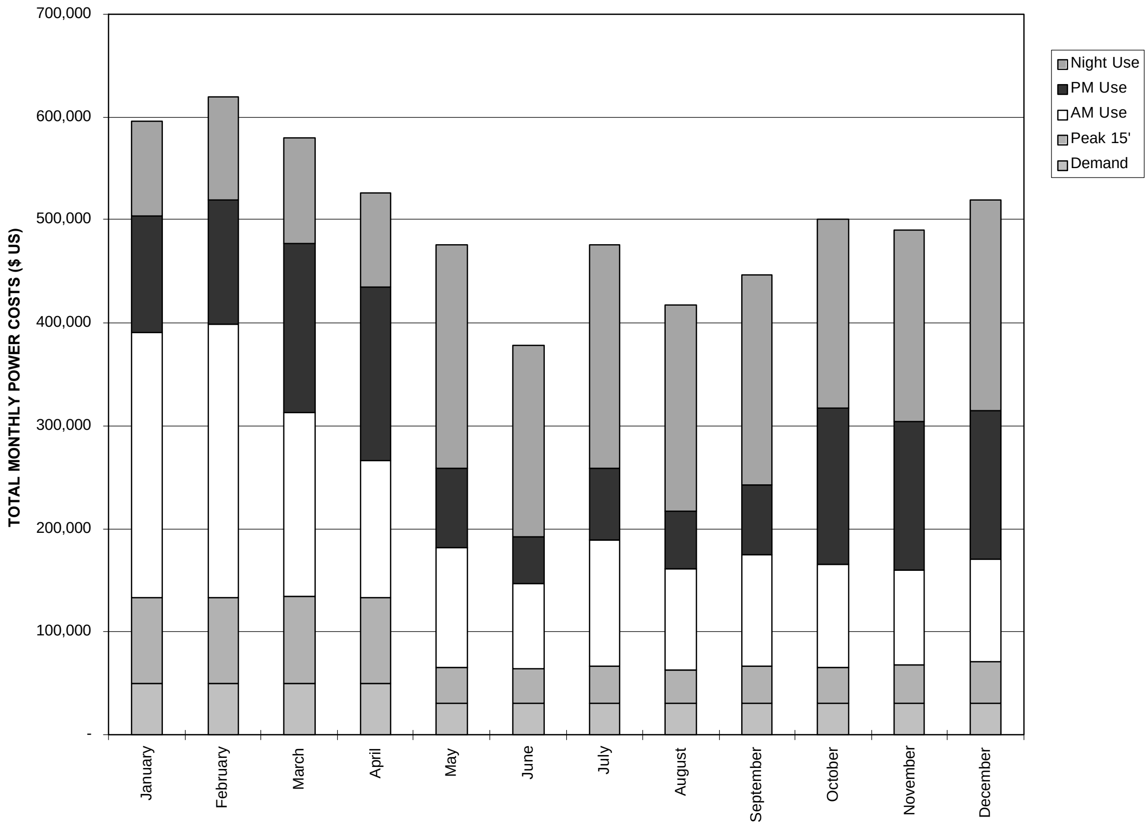


Figure 2.7: Power Costs by Month and Cost Component for 1996

2.3.3 ZEC Costs and Revenues

Established by the Katowice Holding Company, ZEC operates the two coalbed methane and coal-fired boiler houses on the Wesola Mine property. The Wesola Mine and ZEC exchange the commodities listed in Table 2.8 at the rates indicated.

Key Parameters of ZEC's Operations	Rate
Coalbed Methane Purchase Price	$.67
Coal Purchase Price ($/GJ)	$1.69
Water Purchase Price ($/m^3)	$.04
Price of Heat to Wesola ($/GJ)	$4.85

Table 2.8: Key Parameters of ZEC's Operations

ZEC revenues from heat sales generated by gas for 1996 are approximately US$655,000. Figure 2.8 presents revenues by month for heat sales generated by coal and gas for 1996, assuming mine and market heat prices are the same. The 1996 cash flows to and from ZEC, the Wesola Mine, and the market (for district heat), are presented for the commodities of interest on Figure 2.9 for the year 1996. As indicated on the figure, in 1996, ZEC's net income from trade with the Wesola Mine was approximately US$454,000.

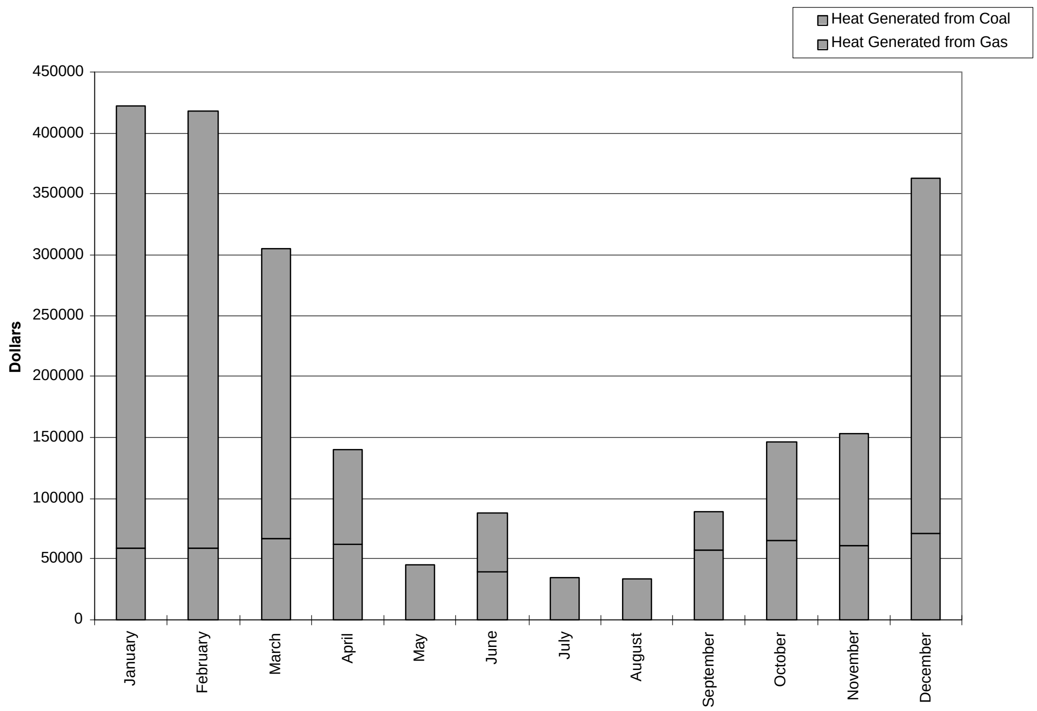
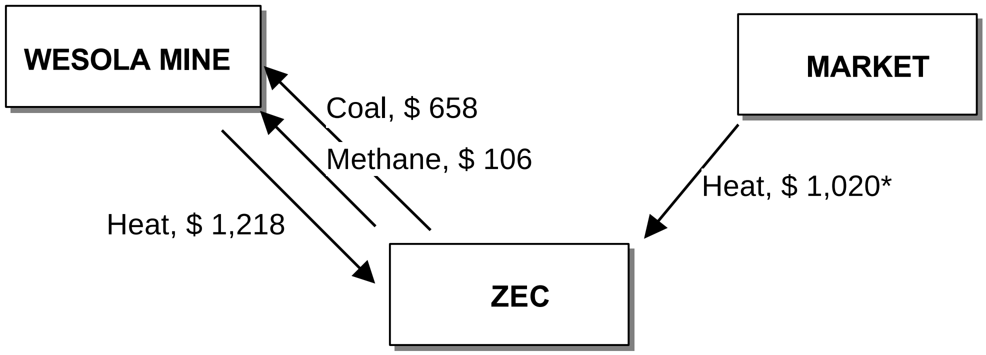


Figure 2.8: ZEC Revenues from Heat Generated from Gas and Coal by Month for 1996



* assumes same market and mine heat price

ZEC NET INCOME FROM TRADE WITH WESOLA	US$1,000's
Heat Sold	$1,218
Methane Purchased	($106)
Coal Purchased	($658)
Water Purchased	Negligible
NET	$454

Figure 2.9: 1996 ZEC Income from Commodities Traded with the Wesola Mine

ZEC and boiler houses operated by the local utility meet district heating demands in the Myslowice township. As Myslowice is a developed area, local planners do not anticipate increased heating demands over the next ten years, except as demanded by changes in climatic conditions.

This report's analysis of the proposed coalbed methane power generation and heat facility does not impair income currently earned by ZEC heat sales. That guideline is important until the Wesola Mine's heat demands increase with the installation of absorption chillers for underground refrigeration.

2.3.4 Proposed Power and Heat Generation Facility Configuration

The proposed project will generate power and heat using a gas turbine fueled by drained coal mine methane and combustion air from a ventilation exhaust shaft. The proposed facility will be designed to accommodate additional modular power and heat generating units as the mine's methane liberation and drainage efficiencies increase.

2.3.4.1 Gas Turbine

The gas turbine proposed for this project was selected to consume the maximum average daily volume of methane presently drained by the Wesola Mine and still operate with lower available fuel volumes at a reduced capacity. A review of turbine vendor performance specifications located a turbine suitable for the available fuel with the best heat rate (i.e., the ABB GT-5 turbine specified in Table 2.9.) Attachment 8 presents detailed performance specifications.

GT-5 Turbine Performance Item	Specification
Gross Power Output at ISO Conditions (MW)	2.712
Heat Rate at ISO Conditions (kJ/kWe-h)	13,245
100% CH4 Requirement at ISO Conditions (sm^3pd)	26,021
Generating Efficiency at ISO Conditions (%)	27.4
Total Heat Generated at ISO Conditions (MW)	7.2
Combustion Intake Mass Flow Rate (kg/s)	15.0

Table 2.9: ABB GT-5 Turbine Specifications under ISO Conditions

2.3.4.2 Impact of Methane in Combustion Air

Because the turbine will be fueled by gob gas, a methane/air mixture of approximately 60 percent methane in air, some of the excess air required for combustion is provided with the fuel (i.e., 0.200 m^3/s, or 0.241 kg/s at standard conditions). Introducing combustion air from the mine's ventilation exhaust shaft (Waclaw Shaft), which discharges air with a methane concentration of approximately 0.2 percent, will provide approximately 0.025 m^3/s, or 2,160 m^3/day of methane (0.016 kg/s at standard conditions), which contributes to a little over 2 percent of the turbine’s fuel requirement. Note that the air in the fuel and the methane in the combustion intake air represents a net increase in the air-to-fuel ratio (although minimal), and should not affect turbine performance.

2.3.4.3 Waste Heat Boiler

As per Attachment 8, manufacturer specifications indicate that the turbine discharge gases will be at 446 °C. The effluent will contain oxygen and nitrogen at concentrations of 15 and 76 percent by volume, respectively. Using a waste heat boiler from the gas turbine’s manufacturer, the proposed installation will recover approximately 40 percent of the heat rate, or 3.96 MWth at ISO conditions. The unfired boiler will supply the existing heat exchanger with water at 70°C, as available from ZEC from the district heating system return, and will provide 10,450 GJ per month of thermal energy under ideal and ISO conditions.

2.3.4.4 Site Location

The power and heat generation plant should be sited adjacent to the Waclaw ventilation exhaust shaft and gas drainage plant on the Wesola Mine property as shown on Figure 2.10. The power plant footprint is approximately 5 m x 10 m. The plant will be interconnected to the ventilation exhaust shaft by ducting, a short gas supply line, and insulated water inlet and return lines.

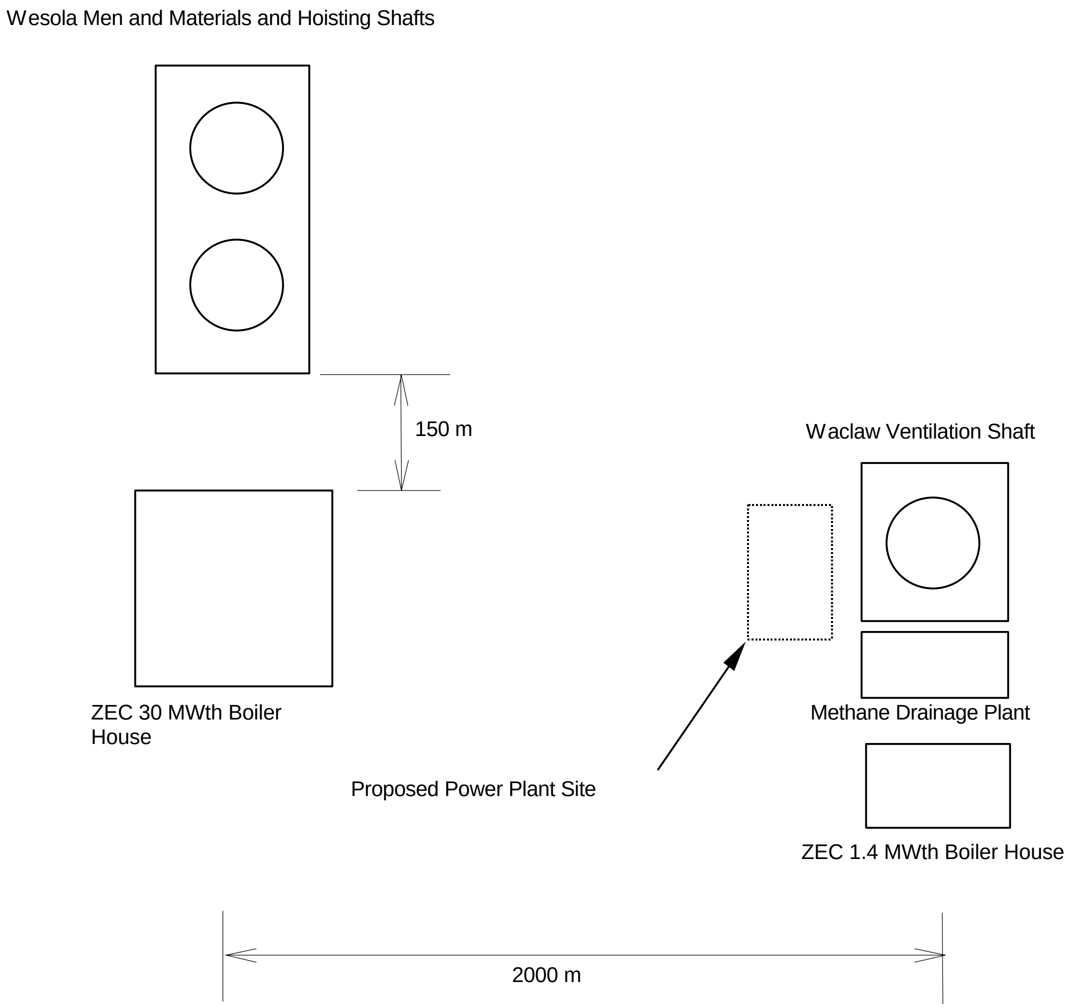


Figure 2.10: Proposed Site Layout for the Power Plant on Wesola Mine Property

2.3.5 Proposed Power and Heat Generation Rates

The proposed power and heat facility will operate so that a favorable rate can be offered to the Wesola Mine and ZEC for power and heat, respectively.

2.3.5.1 Avoided Cost of Power

The proposed project will offset between 2 and 2.5 MWe presently purchased by the Wesola Mine from the local utility. Because facility availability will be dependent to a large part on the recovery of gob gas from underground activities, the Wesola Mine must implement a system of load shedding to use the facility to its advantage. With load shedding, the facility would allow the mine to reduce its demand power from 32 MW to 30 MW or below.

Table 2.10 presents the anticipated distribution of power demand and use charges from the utility and the proposed project with Wesola's 1996 data, assuming a 95 percent turbine availability and the peak demand reduction discussed above. The table shows that the project's avoided cost of power is US$0.036 per kW-h consumed.

Power Cost Components	Totals for 1996	Utility Charges	Proposed Project Charges
Demand Power (MW)	12 x 32 MW	12 x 30 MW	12 x 2 MW
Cost of Demand ($)	446,135	418,251	27,883
Cost per MW ($)	1,162	1,162	1,162
15 Min Peak Power (MW)	12 x 25.8 MW	12 x 23.8 MW	12 x 2 MW
Cost of Peak Power ($)	617,106	569,345	47,761
Cost per MW ($)	1,990	1,990	1,990
Total Consumption MW-h	159,030	142,432	16,598
Consumption Cost ($)	4,963,518	4,445,462	518,056
Cost per kW-h ($)	3.121	3.121	3.121
Total Cost ($)	6,026,758	5,433,058	593,700
Total Cost per kW-h ($)	.038	.038	.036

Table 2.10: Anticipated Cost Distribution Between Utility and the Project Using the Wesola Mine's 1996 Data

2.3.5.2 Cost of Heat

The most logical business arrangement with ZEC is to have the project: (1) compensate ZEC for the increased costs of generating heat with coal (US$1.69 versus US$0.67 per GJ), and (2) not compete with ZEC in heat sales. Table 2.11 summarizes the impact of the proposed power and heat project on ZEC based on 1996 information, assuming similar heat demand and use of all of the methane drained. The data show that if the project sold all of its heat to ZEC at a favorable price of US$3.61 per GJ (Wesola pays US$4.85 per GJ), for resale to the mine or market, the project's impacts on ZEC are minimized.

Heat Component	Value
Heat Demand for 1996 (GJ)	461,390
Heat to be Supplied by Project (GJ)	110,000*
Net Heat to be Supplied by ZEC (GJ)	351,390
ZEC's Cost to Supply (Fired by Gas and Coal)**	$456,960
ZEC's Cost to Supply (Fired by Coal Only)	$593,850
Net Increase in Cost to ZEC by Firing with Coal	$136,890
Market Value of Heat Supplied by Project	$533,500
Less Net Increase in Production Costs to ZEC	$136,890
Favored Heat Purchase Value	$396,610
Favored Heat Purchase Rate (per GJ)	$3.61

*Assumes turbine at full capacity and 95% availability.
** Assumes cost of commodities only (gas, coal, etc.)

Table 2.11: Favorable Price for Heat to ZEC to Compensate for Project's Gas Use

2.3.6 Capital and Operating Costs for the Proposed Facility

2.3.6.1 Facility Capital Costs

Capital cost estimates for the proposed power and heat generation facility are approximately US$2.8 million as itemized in Table 2.12. This cost includes shipping and duty for the imported equipment, and all of the anticipated taxes for purchased goods and services. Costs not included are related to business start-up such as project development costs, transaction costs, interest during construction, and operating capital. Section 3 addresses these costs.

2.3.6.2 Facility Operating Costs

The estimated operating costs for the proposed facility are US$300,000 per year as itemized in Table 2.13. This cost does not account for the cost of gas purchased by the project, or the costs of the parasitic gas and power losses (i.e., by the compressor, in-line fan, and water pump as noted in the table). These costs are considered in the economic analyses presented in Section 4.

Component	Make/Type	Size	Quantity	Cost per Unit (US$)	Installation Cost (US$)	Total Cost (US$)
Gas Processing	All Polish Equipment					
Compressor	Two Stage Reciprocating	200 kW	1	$ 150,000.00	INCLUDED	$ 150,000
Compressor Site Prep/Installation			1	$ 30,000.00	INCLUDED	$ 30,000
Gas Lines	HDPE, 50 m	100 mm	50	$ 24.60	$ 4.00	$ 1,430
Fines/Water Separation, 90% < 5 microns	Mist Eliminator / Fines Filter		1	$ 15,000.00	INCLUDED	$ 15,000
Monitor/Control/Fire Suppression Systems			1	$ 25,000.00	INCLUDED	$ 25,000
Valves and Fittings			1	$ 10,000.00	INCLUDED	$ 10,000
Storage Tank and Connections	High Pressure	250 m3	1	$ 15,000.00	INCLUDED	$ 15,000
Subtotal						$ 246,430
Power Generation	Imported Equipment					
Air Intake Ducting	Steel, 30 m	600 mm	30	$ 150.00	$ 500.00	$ 5,000
In-Line Fan	Axial	35 kW	1	$ 4,000.00		$ 4,000
Turbine with Generator	ABB GT-5	2.6 MW	1	$1,729,000.00	$ 92,000.00	$ 1,821,000
Heat Exchanger	ABB Unfired Boiler	6 Mwth	1	$ 175,750.00	$ 9,250.00	$ 185,000
Utility Connection	Estimate		1	$ 11,000.00	INCLUDED	$ 11,000
Subtotal						$ 2,026,000
Heat Generation						
Piping and Valves	Insulated Steel, 100 m	100 mm	100	$ 32.80	$ 5.30	$ 3,810
In-Line Water Pump	Centrifugal	20 kW	1	$ 2,000.00		$ 2,000
Subtotal						$ 5,810
Subtotal						$ 2,278,240
Other Costs						
Shipping ABB Equipment from Sweden			1	$ 25,000.00	N/A	$ 25,000
Customs Duties		15%	1	$ 285,712.50	N/A	$ 285,713
Value Added Tax On Imported Goods 7%	On Customs Value	7%	1	$ 155,082.38	N/A	$ 155,082
Value Added Tax On All Other Goods and Services		7%	1	$ 26,144.30	N/A	$ 26,144
Local Taxes and Charges, Stamp Fees		3%	1	$ 68,347.20	N/A	$ 68,347
Subtotal						$ 560,286
Total						**$ 2,838,526**

Table 2.12: Capital Cost Estimate for Power and Heat Generation Facility

Operating Costs for Wesola Mine Power and Heat Generation Facility						
Component	**Make/Type**	**Size**	**Quantity**	**Rate** (US$)	**Monthly Costs** (US$)	**Annual Cost** (US$)
Gas Processing						
Gas to Operate Compressor*	Methane from Gob Gas	1,550	cmpd			
Compressor Supplies	Fluids and Consumables		1	$800 per mo.	$ 800.00	$ 9,600
Compressor Maint/Repair	0.5 Overhaul per yr		0.5	$2,000 per mo.	$ 1,000.00	$ 12,000
Support Equipment Supplies and Maintenance			1	$500 per mo.	$ 500.00	$ 6,000
Subtotal						$ 27,600
Power Generation						
Power to Drive In-Line Fan*	35 kW In-Line Axial	307,000	kW-h/yr			
Maintenance/Inspection/Repairs	ABB Service Program			$.006 / kW-h	$ 9,188.00	$ 110,256
Subtotal						$ 110,256
Heat Generation						
Power to Drive Centrifugal Pump*	20 kW Centrifugal	175,000	kW-h/yr			
Operations						
Surface Operators with Benefits	Technicians	Full Time	2	$10.00/hr	$ 4,128.00	$ 49,536
Misc. Supplies				$500 per mo.	$ 500.00	$ 6,000
Subtotal						$ 55,536
General and Administrative**						
Management with Benefits	Manager and Accountant	Full Time	1	$20.00/hr	$ 3,440.00	$ 41,280
Insurance				$ 1000 per mo.	$ 1,000.00	$ 12,000
Subtotal						$ 53,280
Other						
Contingency				15%		$ 37,001
Total Estimated Operating Costs						$ 283,673

* Compressor, Fan and pump will be powered by project. Project will purchase gas from Wesola at prescribed rate.
** Assumes that Wesola Mine or ZEC provides office and support staff as necessary

Table 2.13: Annual Operating Cost Estimate for Power and Heat Generation Facility

2.4 Projected Annual Net Incomes from Drilling, Heat, and Power Sales

The projected net annual gross income to the proposed project, including income from drilling, is presented in Table 2.14. The table assumes that the power generation facility operates at full load at installed conditions and: (1) sells power at 10 percent less than the avoided cost to the mine, and (2) sells heat to ZEC at 75 percent of present costs to the mine. A further assumption is that the new drilling equipment drills 13,600 m per year at a rate of US$50 per meter (see advance rate and drill availability assumptions in Attachment 5).

Costs	Volume	Rate	Annual Cost	Basis
Gas Purchase (cubic meter)	8,811,264	$ 0.022	$ 194,663	at Price Paid by ZEC
Operating Costs			$ 283,673	Heat and Power Op. Costs
Drilling Costs	13,600	$ 38.28	$ 520,600	Drilling Costs
Total Costs			$ 998,935	
Revenue	**Volume**	**Rate**	**Annual Revenue**	**Basis**
Power Sales (kW-hr)	19,731,121	$ 0.032	$ 639,288	Price is 90% of Avoided Cost
Heat (GJ) to ZEC	103,849	$ 3.61	$ 374,894	at 75% of Price to Mine
Drilling (m)	13,600	$ 50.00	$ 680,000	at $50 per m
Total Revenues			$ 1,694,183	
Gross Income			**$ 695,247**	

Table 2.14: Projected Annual Gross Income for Project from Power, Heat, and Drilling with Turbine Operating at Full Load and 95 Percent Availability

3.0 ASSESSMENT OF PROJECT STRUCTURE OPTIONS

A project structure is the arrangement of ownership and financing supported by contractual agreements. The structure recognizes “senior money”—low-risk equity capital—and it rewards high-risk development capital. The structure allows vested interests, the Wesola Mine for example, to obtain a share of the project in consideration for in-kind services such as free ground lease and long-term contracts. This section presents the role of the project developer, the use of a project entity, project ownership issues, and a description of the assumed structure used for the preliminary cash flow model.

3.1 Role of the Developer

3.1.1 Level of Effort

A developer must take scores of coordinated steps (personally or by contract), that build a viable project vehicle ruled by a network of contractual agreements and supported by a flow of funds sufficient enough to reward every participant. Normally the developer’s role continues until closing, after which the developer may assume another project role or turn the project management over to the project entity. A developer will:

- Complete project configuration;
- Obtain development funds;
- Test technical feasibility;
- Hire a financial advisor or investment banker;
- Test financial feasibility;
- Hire professionals: legal and environmental advisors, analysts, or engineers;
- Form project structure;
- Obtain letters of intent (LOI) from each owner and funding source;
- Negotiate contracts: mine, energy markets, equipment suppliers, or engineering-procurement-construction (EPC) contractor;
- Obtain permits: import, environmental, or local;
- Schedule and manage activities for participants, suppliers, civil servants, funding sources, or advisors; and
- Maintain development budget and report to supplier of development funds.

The developer must have the forbearance and perseverance to undertake a process that can take months, even years, and he must have the fiscal support to sustain him and to pay for the many services that the project demands before it becomes self-sustaining. A motivated developer associated with a well-financed entity with access to “patient money” is best qualified to sustain project demands until closing.

3.1.2 Rewards

Paid developers take no risk and receive no reward except payment for their time. This is the least common method of project development as a paid developer has little incentive to succeed. More commonly, developers are motivated by reward (roughly proportional to the magnitude of the risk), and pay for professional advice, reports, fees, and other out-of-pocket expenses to fulfill project needs. The mission to Poland did not identify any person or firm with the interest and financial backing to develop the project without outside support. A preferred approach is for interested individuals to locate an established entity that has an interest in the project, and which can provide a source of development funding (see Section 4.1). These individuals may then arrange to obtain funding for expenses and fees and to negotiate a reward arrangement to repay risks and efforts based on project milestones as follows:

- Reimbursement of deferred salary (at closing)
- Reimbursement of expenses (at closing)
- Developer's fee (at closing)
- Bonus on successful start-up
- Management contract through X years of operation
- Small equity share

(Note that payment options are subject to competing interests from the development capital supplier, the equity partners, and the debt suppliers.)

3.2 Use of a Project Entity

Most energy projects, especially those with complex ownership, choose to create a new corporation or other limited-liability legal entity to create and embody the ownership and management of the project. The entity is empowered to raise money, make contracts, hire contractors and personnel, and operate the business. The entity's rights and duties are described in the contracts drawn up by the developer and the project owners.

During the mission to Poland potential investors expressed a preference for an entity separate from the Wesola Mine. This step relieves the project from mine-related concerns (e.g., limited available capital and difficult finances), and facilitates funding from environmental sources (all mines have environmental liabilities). Most of these investors feel that it is appropriate to include the mine as a minor shareholder in the project, particularly as the mine would sell gas to the project and purchase power and heat.

This report does not prescribe a preferable entity, as this is ultimately the project developer's decision; however, it is apparent that a limited liability company (SP. Zo.o.), or a joint stock company (S.A.), allows for foreign investment contributions and part ownership. Attachment 9 presents the differences between the two entities available to a foreign investor.

3.3 Discussion of Ownership Options

Ownership shares of the proposed drilling and power generation project at the Wesola Mine may accrue to entities that have benefited from the project in one of three ways: (1) time and effort—"sweat equity"— and deferred payment, (2) in-kind services or items of value, and (3) equity capital (cash).

3.3.1 Sweat Equity and Deferred Payments

These equity forms qualify as high-risk equity, provided they remain in the project well beyond start-up and through the riskier early operating years.

3.3.1.1 Developer

The most significant incentive for a developer is the potential to earn a share of a project that could more than compensate him for the risks he has taken. Moreover, investors bringing equity and debt capital to the project prefer that the developer's share be large enough to entice him to implement the project with all the means at his disposal.

3.3.1.2 Suppliers

Other major participants may wish to invest time and effort during the development phase. Normally they will "cash out" at closing, but they may opt to allow the value of their contribution to remain in the project as part of its capitalization. One example can be an ECP contractor who donates preliminary design and other engineering services to enable the project to get its permits. An example of a deferred payment is the major equipment supplier that leaves its final ten-percent payment "in the project" during the critical first year or two before cashing out.

3.3.2 In-kind Equity

When a major participant donates valuable items or services to a project that requires cash compensation, it may elect to exchange that item or service for a project ownership share. The following three subsections discuss potential examples for this drilling and power project.

3.3.2.1 Wesola Mine

The mine is in a position to gain ownership by: (1) providing assistance at the project development level, (2) providing support to detailed engineering for the surface power facility, (3) assisting with management during construction (4) donating the site, access rights, personnel, and any buildings that may be appropriate, and (5) effecting an exclusive power purchase and gas sales agreement (see Section 3.4.4).

3.3.2.2 ZEC

By using personnel already on site, ZEC can gain an ownership position by assisting at the development stage and by conducting some of the operating duties, such as monitoring turbine/generator performance or providing light maintenance, office services, and security.

3.3.2.3 ZOK

ZOK can gain ownership by: (1) providing assistance at the project development level, (2) guiding the Polish Higher Mining Authority through the equipment approval process, (3) providing engineering services to incorporate directional drilling into the Wesola Mine's degasification program, and (4) providing drilling technicians at no cost through the directional drilling training period. These investments can be traded for either a project share or a percentage of margins earned on drilling fees collected during the operation phase.

3.3.3 Cash Equity

The proposed drilling and power project will need to receive the majority of equity from an investor in cash at financial closing. This is especially true of this first-of-its-kind project for the Polish mining industry. Debt suppliers need assurance that a major share of capital is supplied by someone who assumes the risk of failure. Fortunately for the proposed project, two government agencies expressed interest in providing equity capital with favorable terms.

The project qualifies for Polish government assistance because of its strong environmental benefits. For these reasons, part or all of the equity (including some in the form of a grant), and some debt, will likely come from national or bilateral agencies. More promising sources of other equity and debt are discussed below. Attachments 10 and 11 present additional details on financing sources, including potentially interested foreign programs

3.3.3.1 ECOFUND

The ECOFUND, which manages the "debt for environmental swap" (Attachment 12), can grant funds for project investment at the closing (up to 30 percent) that will be considered as equity by the debt suppliers. This capital is “free” in the sense that it need not earn a return (i.e., project earnings may be applied only to other equity suppliers, thus enhancing their rate of return).

3.3.3.2 The National Fund for Environmental Protection and Water Management ("National Fund")

The National Fund and its local associate, the Voivodship Fund (Attachment 13), provide grants or cash equity (at National Fund level only) for an ownership position in the project. Although these funds prefer lending capital (with loan remission provisions), they will consider providing cash equity for investments in hard assets of commercially viable projects. To compensate for risk, the funds request strong equity positions (up to 40 percent), in projects developed by new companies, or by coal mining operations. As the National and Voivodship funds are supported by royalties on revenues from coal and methane sales and from environmental fees charged to mines, the funds may apply the earnings from their equity contribution in the project to offset fees charged to mine entities that are co-participants in the same project (Wesola Mine, Katowice Holding Co., or ZEC). Although possible, this arrangement for compensating mine entities that have an ownership interest in the proposed project must be investigated further.

3.3.3.3 Private Sources

The proposed project may need to supplement the above equity sources with private equity. This investigation does not identify private sources of equity, although a portion of this may come from the developer funds supplier. Unfortunately, private equity suppliers will demand the maximum project share for their money, and negotiating an agreement will require a skillful financial intermediary.

3.4 Structure Assumptions for Financial Model

In developing the financial model to assess the viability of the proposed project, the analysis assumes that a separate project entity will be formed and owned by equity contributors; equity will need to represent up to 40 percent of the proposed project capital costs (see Section 3.4.2). Equity contributions during project operations also need consideration as project owners.

3.4.1 Total Estimated Project Costs

Table 3.1 presents the total estimated capital costs for the proposed project, including project development, procurement, and construction separated into two categories: hard costs, and potential sweat and in-kind contributions. The estimate includes an overall project cost contingency of 7.5 percent.

Components	Costs	Hard Costs	Sweat / In-Kind
Project Development			
Project Developer	$ 50,000	$ 20,000	$ 30,000
Financial / Banking	$ 20,000	$ 20,000	
Legal, Environmental, Engineering	$ 80,000	$ 50,000	$ 30,000
Permitting	$ 15,000	$ 15,000	
Transactions	$ 25,000	$ 25,000	
Sub-Total	$ 190,000	$ 130,000	$ 60,000
Project Construction			
Capital/Interest During Construction	$ 150,000	$ 150,000	
Construction Management	$ 20,000	$ -	$ 20,000
Drilling Equipment			
Procured Cost	$ 992,000	$ 992,000	
Approval by Higher Mining Authority	$ 40,000	$ 32,500	$ 7,500
Directional Drilling Training	$ 175,000	$ 140,000	$ 35,000
Shipping and Insurance	$ 28,000	$ 28,000	
Import Duties	$ 204,000	$ 204,000	
Taxes	$ 85,680	$ 85,680	
Power and Heat Equipment			
Procured Cost	$ 2,278,240	$ 2,278,240	
Shipping	$ 25,000	$ 25,000	
Import Duties	$ 285,713	$ 285,713	
Taxes	$ 249,574	$ 249,574	
Subtotal	$ 4,533,206	$ 4,470,706	$ 62,500
Total	$ 4,723,206	$ 4,600,706	$ 122,500
7.5 % Contingency	$ 354,240	$ 345,053	$ 9,188
Total Costs	$ 5,077,447	$ 4,945,759	$ 131,688

Table 3.1: Total Estimated Project Costs (US$)

3.4.2 Financing Structure

3.4.2.1 Debt-to-Equity Ratio

As the proposed project is a first for Poland, the model assumed a 60/40 debt-to-equity ratio. Later projects may be able to increase debt leveraging with 70/30 and 80/20 ratios. Typically banks will only lend 80 percent of a project's capital if they have encountered similar and consistently successful projects.

3.4.2.2 Equity Capital ($1.98 million)

Potential sources for up to 40 percent cash equity include:

- 20 percent from ECOFUND in the form of a grant,
- 10 percent from National Fund, and
- 10 percent from project development and private sources.

3.4.2.3 Sweat and In-kind Equity ($131,688)

The mission identified potential sweat and in-kind sources that can defer, at a minimum, approximately two percent of total project costs. These include: (1) project development efforts as defined in Section 3.1 by the developer, the Wesola Mine, ZEC, and ZOK, (2) engineering and permit assistance, including support of detailed engineering efforts, and assistance with construction management that can be provided by the Wesola Mine, ZEC, or ZOK, (3) equipment approval efforts provided by the Wesola Mine or ZOK, and (4) technicians with drilling experience for training provided by the Wesola Mine or ZOK.

These or other entities can contribute more noncash equity to the project. However, to be conservative the economic projections kept this contribution to less than three percent of overall costs.

3.4.3.4 Debt Capital ($2.97 million)

The following are likely sources for the 60 percent debt capital:

- 30 percent from National Fund and/or Voivodship Fund
- 30 percent from commercial banks

3.4.3 Ownership

Project owners will be shareholders (individuals, companies, or financial institutions) that have contributed equity to the project: either sweat, in-kind, or cash. The financial model simulating the 60/40 debt-to-equity ratio ("Base Case"), assumed that only half of the equity contribution represents project ownership because the ECOFUND does not require a share (grant funding). Equity provided from private sources will require approximately half of the ownership, and the National and Voivodship funds will request an additional one-third. The remaining one-sixth interest can be rewarded to the sweat and in-kind contributors. Pending further investigation and approval (from the State Treasury and others), the National and Voivodship Funds can reward a portion of their dividends to mine-related co-owners by posting their dividends against the company's environmental fees.

3.4.4 Roles for the Wesola Mine

The relationship between the proposed project and the Wesola Mine must be carefully negotiated because of the critical impact the mine has on the project. Project investors will insist that the relationship be formalized with a series of agreements.

As the host and supplier of the gas, the Wesola Mine is in an influential position, and ultimately will decide whether or not the project may go forward. On the other hand, if the mine tries to control too much of the project or negotiates for unrealistic prices on the gas, drilling fees, and thermal energy prices, it may jeopardize the project's financial viability. In order to resolve this issue, it is advised that the mine be provided an earned ownership in the project and that the project negotiate power purchase and heat sales agreements that benefit the mine.

To earn an ownership position, the Wesola Mine may provide in-kind services during project development and construction as presented above, or it may provide the following during operations:

- Host project's power plant, office, means of access, pipelines, or power lines;
- Operational support personnel;
- Gas at the same subsidized rate negotiated with ZEC; or
- Gas supply coordination with project needs.

In return, the project will supply power and heat on a favored-nation basis (less than avoided cost and below market rates), and possibly reduce the mine's environmental fee obligations.

4.0 ECONOMIC ANALYSIS

This section presents the parameters used in the financial evaluations of the proposed project, the base case scenario and sensitivity conditions, project cash flows, and key economic results.

4.1 Parameters Incorporated in Financial Analysis

4.1.1 General Assumptions

4.1.1.1 Project Structure

As described in Section 3, the analysis assumes that the project is owned and operated by a separate entity, either a limited liability (Sp. Z o.o.) or joint stock company (S.A.) comprised of equity contributors.

The Wesola Mine, ZEC, and ZOK, all with equity stakes in the project, provide operational assistance for the surface power and heat generation facility, and underground drilling. Underground drilling is not limited to the Wesola Mine.

Economic analyses do not account for the cost savings to the mine for power and degasification, or for benefits to ZEC. These are quantified separately in Section 5.

4.1.1.2 Project Period

The analysis considered a ten-year project period without additional investments to expand power and heat generation, or drilling capabilities.

4.1.1.3 Project Size

The proposed combined heat and power project is of sufficient size to use all of the gas currently drained by the Wesola Mine (including some ventilation air as combustion air), with the provision to use additional drained gas. Projecting future methane liberations and an anticipated increase in methane drainage efficiency with the introduction of new drilling technology, the project will require all of the methane drained for the first three years, after which additional gas would be available for heating or additional power capacity as needed. Attachment 14 presents an economic projection of the power and heat facility with increased methane liberation and capture.

As indicated in Section 2, the project will drill horizontal gob boreholes at the Wesola Mine as necessary and then move to other mine operations in the Upper Silesian Basin (Section 2.2.5). The financial analyses assume that the project will drill two shifts per day and that the drill will operate approximately 80 percent of the time. The remaining time accounts for movement of the drill to other drilling locations. With an average advance rate of 32 m per shift for drilling in rock, the equipment will drill approximately 13,600 m per year.

4.1.1.4 Project Revenues

Total project revenues depend on pricing schedules set for the base case and sensitivity analyses discussed below. Attachment 14 presents project revenues for the base case period.

4.1.1.5 Project Costs

Section 3, Table 3.1 presents total project capital costs at US$5.0 million. Annual estimated operating costs are approximately US$1.0 million per year as summarized separately for drilling and power and heat in Table 2.14 for operations assuming that the project pays the Wesola Mine the same price for gas as ZEC presently pays. Attachment 14 contains itemized expenses and projections over the project period.

4.1.2 Economic Parameters

4.1.2.1 Inflation

The Polish inflation rate at the time of the mission was approximately 17 percent, but economists predict potentially dramatic reductions. In order to facilitate interpretation, all financial analyses are on a constant U.S. dollar basis except as discussed below.

4.1.2.2 Energy Prices

Economists, including the regulating Ministry of Finance, forecast that energy prices will escalate at 5 percent above inflation as these are presently below economic costs. Energy prices escalated in this analysis include those for gas, power, and heat.

4.1.2.3 Interest Rates

Annual interest rates for loans obtained from commercial banks in Poland range between 23 and 26 percent at the time of the mission. Adjusting for inflation at 17 percent, the effective, or real, rate is calculated at between 5.1 and 7.7 percent. For the financial analyses, rates were selected to represent loans from both government and commercial banks as presented for the base case and sensitivity conditions below. Loan interest rates were kept constant through the course of the project period.

4.1.3 Taxes

4.1.3.1 Corporate Tax Rate

As per the Ministry of Finance, the corporate tax rate for both limited liability and joint stock companies in Poland is currently 38 percent regardless of income. According to legislation enacted in 1996, this rate will decrease by 2 percent per year to reach a level of 32 percent by the year 2000. There are no additional local or regional corporate income taxes in Poland.

The financial analyses accounted for the varying tax schedule and incorporated the following allowances that reduce gross income, as prescribed by Polish tax law.

4.1.3.2 Allowances

- Business Losses: Business losses incurred, as calculated for tax purposes, may be carried forward. Losses incurred during one fiscal year can offset income earned during the next three consecutive years in equal portions provided that profits in any of these years cover at least one-third of the loss.

- Depreciation: Polish tax law allows depreciation of tangible equipment, typically by the straight-line method, or by accelerated methods with approval. As per the Ministry of Finance, Bill of Register No. 7, Position 34, assets valued over US$750 can be depreciated according to group. For drilling equipment, Group 510, straight-line allowances are between 17 to 20 percent per year. For machines and equipment relating to mining, Group 51, the annual allowance is between 14 and 17 percent. The financial analyses depreciated assets using the straight-line method, those related to drilling at 17 percent and those related to the surface facility at 14 percent.

- Amortization: Polish tax law also allows amortization of intangible assets. The financial analyses amortized these over a five-year period.

- Other: The financial model assumed that import duties and taxes paid on equipment were amortized over five years to offset revenues.

4.1.3.3 Value Added Tax (VAT)

VAT paid by the project can be used to offset VAT collected by the project from sales of power and heat. In Poland, VAT is treated separately and any surplus VAT paid can be used to offset future VAT collected. Net VAT is due to the taxation office.

The financial analyses assumed that the VAT paid on purchase of equipment and purchase of gas is offset by VAT collected from power, heat, and drilling sales.

4.2 Base Case and Sensitivity Conditions

4.2.1 Financing Structure

4.2.1.1 Debt-to-Equity Ratio

As per Section 3.4, the base case debt-to-equity ratio used for the financial analyses is 60/40. Base case equity and debt sources are designated in Section 3.4.2. We selected this condition to represent the worst case (typical of new projects) as more costly hard currency is required relative to leveraged, or lower-cost, money.

Analyses for debt-to-equity ratios of 60/40 and 70/30 are made, both with and without the ECOFUND grant of 20 percent of the project costs (see Section 3).

4.2.1.2 Interest Rate

For the financial analyses, a real interest rate is used for debt capital to accurately represent the proportion of debt sought by the project from the government (5 percent) and commercial sources (8 percent). Based on information presented in Section 3, a blended rate of 6.5 percent for the 60/40 debt-to-equity ratio (base case with and without ECOFUND grant) is calculated, as is 6.7 percent for the 70/30 condition, also with and without the grant. Note that the National and Voivodship fund debt (30 percent) and equity contribution (10 percent National Fund) is maintained for both debt-to-equity ratios.

4.2.1.3 Remissions

The analyses assume that the loan from the National and Voivodship Funds qualifies for remission after the project fulfills its environmental obligations (three years to operate power and heat facility to peak load). The analyses simulate payment of 50 percent of the principal over three years and that remission is granted for 40 percent of the original debt. The project pays interest over three years on the average principal balance and then pays the remaining 10 percent of the principal in Year 4 (with interest).

4.2.2 Prices

Table 4.1 presents first-year base case prices charged by the project for drilling, heat, and power. All analyses assume that the mine charges the project the same rates for gas and water as presently charged to ZEC. Table 4.1 also includes these prices. The analysis escalated only prices for power and heat.

Commodity	**Price (US$)**	**Comments**
Power ($/kW-hr)	.032	10% less than avoided cost
Heat ($/GJ)	3.61	75% of price paid by mine
Drilling ($/m)	50.00	See Attachment 3
Gas ($/m^3)	.022	Price presently paid by ZEC
Water ($/m^3)	.43	Price presently paid by ZEC

Table 4.1: First-Year Prices for Commodities Used in Analyses

First-year prices for the sensitivity evaluations are shown in Table 4.2. Power and heat prices charged by the project were further reduced.

Commodity	**Price (US$)**	**Comments**
Power ($/kW-hr)	.029	20% less than avoided cost
Heat ($/GJ)	3.15	65% of price paid by mine
Drilling ($/m)	50.00	See Attachment 3
Gas ($/m^3)	.022	Price presently paid by ZEC
Water ($/m^3)	.43	Price presently paid by ZEC

Table 4.2: First-Year Prices for Commodities Used in Sensitivity Analyses

4.3 Results

4.3.1 Base Case with ECOFUND

Table 4.4 presents the cash flow statement for the base case model (using the base case commodity prices as presented in Table 4.1) with an ECOFUND grant of US$945,000. The statement presents the project's anticipated constant dollar cash flow over the project period and calculates the project's internal rate of return (IRR), net present value (NPV) at a rate of return on investment of 10 percent, and its pay-back period (years to pay initial investment).

With the base case commodity prices and with the ECOFUND Grant, the project would provide an IRR of 31 percent and a net present value US$1.07 million, and would pay the initial equity contribution of US$945,000 in 4.9 years.

4.3.2 Base Case without ECOFUND

Table 4.5 presents the cash flow statement for the base case model (using the base case commodity prices in Table 4.1), but without a grant from the ECOFUND. Without the grant, the project is marginally economically viable, with a projected internal rate of return of slightly more than 10 percent, an NPV of less than US$50 thousand (at 10 percent), and a pay-back period of 7 years. The initial equity contribution to project in this case is approximately US$2.0 million.

4.3.3 Sensitivity Analyses

Further analyses vary the prices the project would charge the Wesola Mine and ZEC for power and heat, and the project financing structure. Table 4.2 presents the sales prices for power and heat used for the sensitivity analyses (power price at 20 percent below avoided cost and heat price at 65 percent of current market price). The alternative debt-to-equity ratio investigated in the sensitivity studies is 70 percent debt and 30 percent equity.

Table 4.3 presents a matrix of the commodity pricing and project finance permutations evaluated and the key economic indicators calculated for each scenario.

4.4 Summary of Economic Analyses

Economic analyses of the proposed power, heat, and drilling project were conducted with the parameters provided from the recommended project financing sources as presented in Section 3.4.2. These include both debt and equity financing from government sponsored sources which fund environmental projects, and from commercial and/or private banks and investors. These analyses evaluate the impact of the ECOFUND grant, a 20 percent unearned contribution of capital (US$945,000), and of alternate debt-to-equity ratios (60/40 and 70/30). In all cases, the government sponsored equity and debt sources (National and Voivodship Funds), contribute a maximum of 10 percent of equity, and 30 percent debt. The analyses assume that the remaining balance of equity and debt is provided by interested commercial banks and private investors.

Without ECOFUND Grant	IRR (%)	NPV (10%) ($1000's)	Pay Back Period (Years)
Debt to Equity 60/40, Base Case Prices	10.3	40	7.0
Debt to Equity 60/40, Sensitivity Prices	5.4	(541)	8.3
Debt to Equity 70/30, Base Case Prices	10.5	554	7.4
Debt to Equity 70/30, Sensitivity Prices	5.5	(507)	8.3
With ECOFUND Grant			
Debt to Equity 60/40, Base Case Prices	23.9	1,067	4.9
Debt to Equity 60/40, Sensitivity Prices	14.5	352	6.5
Debt to Equity 70/30, Base Case Prices	28.0	1,080	4.8
Debt to Equity 70/30, Sensitivity Prices	18.4	520	6.3

Table 4.3 Scenarios Simulated with Key Economic Indicators

The economic analyses are made on a constant dollar basis, with escalation of energy prices as these are projected to exceed Poland's inflation projections (five percent), and incorporate other financial assumptions from this section. The analyses also specifically define the prices of commodities bought and sold by the project and for providing drilling services. Prices of commodities purchased by the project are at current market (between the Wesola Mine and ZEC) value, while prices for power and heat produced by the project are favorable to both the Wesola Mine and ZEC. The proposed price for heat sold by the project to ZEC considers ZEC's additional costs of producing heat with coal rather than coalbed methane.

Based on the specific parameters and assumptions described above, the financial analyses indicate that the proposed power, heat, and drilling project at the Wesola Mine is economically viable. The sensitivity studies show that the project is only marginally viable without the ECOFUND Grant and with base case power and heat prices. It is likely that very favorable heat and gas prices, such as those used in the sensitivity analyses, will be necessary to interest the Wesola Mine and ZEC. Both of these entities are key to the proposed project (the project trades commodities solely with these entities) and hold, therefore, very influential positions. The analyses show that the ECOFUND grant is necessary with very favorable heat and gas prices. It is also required to attract commercial and private debt and equity sources, and to increase the likelihood of project development.

CASH FLOW STATEMENT	Years	0	1	2	3	4	5	6	7	8	9	10
Revenue and Expenditures												
Revenue			$ 1,412,963	$ 1,557,913	$ 1,711,998	$ 1,836,876	$ 1,894,720	$ 1,955,456	$ 2,019,228	$ 2,086,190	$ 2,156,499	$ 2,230,324
Equity Investment	40% Eq.Less ECOFUND Grant	$ 945,292										
Operating Costs			$ 963,306	$ 984,435	$ 1,008,224	$ 1,029,619	$ 1,040,886	$ 1,052,717	$ 1,065,139	$ 1,078,183	$ 1,091,878	$ 1,106,258
Gross Margin		$ (945,292)	$ 449,657	$ 573,478	$ 703,774	$ 807,257	$ 853,833	$ 902,738	$ 954,089	$ 1,008,007	$ 1,064,621	$ 1,124,066
Taxes												
Depreciation	Tangible Equipment		$ (487,594)	$ (487,594)	$ (487,594)	$ (487,594)	$ (487,594)	$ (467,754)	$ (318,954)	$ (45,565)	$ -	$ -
Interest for National/Voivodship Fund	40% Forg.after 50% Principal Paid		$ (64,977)	$ (53,137)	$ (41,297)	$ (33,609)	$ -	$ -	$ -	$ -	$ -	$ -
Interest for Commercial Loan	Over 7 Years		$ (113,435)	$ (100,722)	$ (86,992)	$ (72,164)	$ (56,149)	$ (38,853)	$ (20,174)	$ -	$ -	$ -
Amortizataion	Over 5 Years		$ (203,593)	$ (203,593)	$ (203,593)	$ (203,593)	$ (203,593)	$ -	$ -	$ -	$ -	$ -
Business Loss Carry Forward	3 Years Amortization			$ -	$ -	$ (3,432)	$ (35,499)	$ (38,568)	$ -	$ -	$ -	$ -
Corporate Tax	40% to 32% by 2000		$ -	$ -	$ -	$ 2,334	$ 22,719	$ 114,420	$ 196,788	$ 307,982	$ 340,679	$ 359,701
Net Income After Tax			$ (419,942)	$ (271,568)	$ (115,703)	$ 4,531	$ 48,279	$ 243,144	$ 418,174	$ 654,461	$ 723,942	$ 764,365
Cash Flow Adjustment												
Plus Depreciation			$ 487,594	$ 487,594	$ 487,594	$ 487,594	$ 487,594	$ 467,754	$ 318,954	$ 45,565	$ -	$ -
Plus Amortization			$ 203,593	$ 203,593	$ 203,593	$ 203,593	$ 203,593	$ -	$ -	$ -	$ -	$ -
Plus Loss Carry Forward			$ -	$ -	$ -	$ 3,432	$ 35,499	$ 38,568	$ -	$ -	$ -	$ -
Less Principal Paid - Funds	16.7% per year for 3 years		$ (236,796)	$ (236,796)	$ (236,796)	$ (70,755)	$ -	$ -	$ -	$ -	$ -	$ -
Less Principal Paid - Bank	Payment		$ (158,912)	$ (171,625)	$ (185,355)	$ (200,183)	$ (216,198)	$ (233,493)	$ (252,173)	$ -	$ -	$ -
Cash Flows												
Net Cash Flow		$ (945,292)	$ (124,463)	$ 11,199	$ 153,334	$ 428,212	$ 558,767	$ 515,971	$ 484,955	$ 700,026	$ 723,942	$ 764,365
Net Cum. Cash		$ (945,292)	$ (1,069,754)	$ (1,058,556)	$ (905,221)	$ (477,009)	$ 81,758	$ 597,729	$ 1,082,683	$ 1,782,709	$ 2,506,651	$ 3,271,016
Economic Indicators												
Internal Rate of Return	23.6%											
Net Present Value 10%	$ 1,067,126											
Pay Back Period (Years)	4.9											

Table 4.4: Cash Flow Statement for Base Case Model with ECOFUND Grant

CASH FLOW STATEMENT	Years	0	1	2	3	4	5	6	7	8	9	10
Revenue and Expenditures												
Revenue			$ 1,412,963	$ 1,557,913	$ 1,711,998	$ 1,836,876	$ 1,894,720	$ 1,955,456	$ 2,019,228	$ 2,086,190	$ 2,156,499	$ 2,230,324
Equity Investment	No Ecofund Grant	$ 1,978,304										
Operating Costs			$ 963,306	$ 984,435	$ 1,008,224	$ 1,029,619	$ 1,040,886	$ 1,052,717	$ 1,065,139	$ 1,078,183	$ 1,091,878	$ 1,106,258
Gross Margin		$ (1,978,304)	$ 449,657	$ 573,478	$ 703,774	$ 807,257	$ 853,833	$ 902,738	$ 954,089	$ 1,008,007	$ 1,064,621	$ 1,124,066
Taxes												
Depreciation	Tangible Equipment		$ (487,594)	$ (487,594)	$ (487,594)	$ (487,594)	$ (487,594)	$ (467,754)	$ (318,954)	$ (45,565)	$ -	$ -
Interest for National/Voivodship Fund	40% Forg.after 50% Principal Paid		$ (67,992)	$ (55,603)	$ (43,214)	$ (35,168)	$ -	$ -	$ -	$ -	$ -	$ -
Interest for Commercial Loan	Over 7 Years		$ (118,698)	$ (105,395)	$ (91,028)	$ (75,512)	$ (58,754)	$ (40,656)	$ (21,110)	$ -	$ -	$ -
Amortizataion	Over 5 Years		$ (203,593)	$ (203,593)	$ (203,593)	$ (203,593)	$ (203,593)	$ -	$ -	$ -	$ -	$ -
Business Loss Carry Forward	3 Years Amortization			$ -	$ -	$ (1,797)	$ (34,631)	$ (40,552)	$ -	$ -	$ -	$ -
Corporate Tax	40% to 32% by 2000		$ -	$ -	$ -	$ 1,222	$ 22,164	$ 113,209	$ 196,488	$ 307,982	$ 340,679	$ 359,701
Net Income After Tax			$ (428,220)	$ (278,707)	$ (121,655)	$ 2,371	$ 47,098	$ 240,568	$ 417,537	$ 654,461	$ 723,942	$ 764,365
Cash Flow Adjustment												
Plus Depreciation			$ 487,594	$ 487,594	$ 487,594	$ 487,594	$ 487,594	$ 467,754	$ 318,954	$ 45,565	$ -	$ -
Plus Amortization			$ 203,593	$ 203,593	$ 203,593	$ 203,593	$ 203,593	$ -	$ -	$ -	$ -	$ -
Plus Loss Carry Forward			$ -	$ -	$ -	$ 1,797	$ 34,631	$ 40,552	$ -	$ -	$ -	$ -
Less Principal Paid - Funds	16.7% per year for 3 years		$ (247,783)	$ (247,783)	$ (247,783)	$ (74,038)	$ -	$ -	$ -	$ -	$ -	$ -
Less Principal Paid - Bank	Payment		$ (166,285)	$ (179,588)	$ (193,955)	$ (209,471)	$ (226,229)	$ (244,327)	$ (263,873)	$ -	$ -	$ -
Cash Flows												
Net Cash Flow		$ (1,978,304)	$ (151,101)	$ (14,890)	$ 127,795	$ 411,846	$ 546,686	$ 504,547	$ 472,618	$ 700,026	$ 723,942	$ 764,365
Net Cum. Cash		$ (1,978,304)	$ (2,129,404)	$ (2,144,295)	$ (2,016,500)	$ (1,604,654)	$ (1,057,968)	$ (553,421)	$ (80,804)	$ 619,222	$ 1,343,164	$ 2,107,529

Economic Indicators	
Internal Rate of Return	10.3%
Net Present Value 10%	$ 40,365
Pay Back Period (Years)	7

Table 4.5: Cash Flow Statement for Base Case Model without ECOFUND Grant

5.0 PROJECT BENEFITS AND RISKS

This section examines the benefits of the proposed project to the Katowice Holding Company, Wesola Mine, ZEC, the USB Coal Mining Industry, and the environment. It also summarizes project risks for the prospective developer, investors, and lenders.

5.1 Project Benefits

The proposed project will provide numerous benefits to the Katowice Holding Company and its subsidiaries, the USB coal mining industry, and to the global environment.

5.1.1 Benefits to the Katowice Holding Company

Any efforts to reduce operating costs and improve revenues from coal production at the Wesola Mine would benefit the holding company. In 1993 the Wesola Mine operated at a US$21 million loss. The power, heat, and drilling project proposed herein could potentially result in savings of between US$1 million and US$3 million per year per longwall panel, primarily by eliminating methane-related coal production delays. The proposed project would introduce a lower-cost, readily controllable system of gob degasification that could improve efficiency in each of the company's mines.

5.1.2 Benefits to the Wesola Mine

Presented below are the benefits of the proposed power, heat, and drilling project to the Wesola Mine.

5.1.2.1 Power Cost Savings

The Wesola Mine will save over US$130,000 per year by purchasing power from the project at a favored cost of 20 percent less than avoided cost.

5.1.2.2 Increased Revenues from Gas Sales

As the proposed project will purchase all of the gas drained by the mine, gas sales will increase by 54 percent. Using 1996 drainage volumes, the Wesola Mine would gain additional revenue in excess of US$57,000 per year.

5.1.2.3 Reduced Degasification Costs

The Wesola Mine could potentially reduce its degasification costs by US$364,000 per longwall panel by avoiding up to 40 percent of overlying gallery infrastructure through the use of horizontal gob boreholes.

5.1.2.4 Increased Revenues from Increased Coal Production

Because the proposed horizontal borehole system can be readily controlled and optimized, we anticipate improvements in district methane drainage efficiencies and in recovered gas quality. Improved degasification efficiencies will result in (1) reduced production delays due to methane gas and (2) increased longwall coal production. With a 25 percent increase in district drainage efficiency, the Wesola Mine could increase revenues from coal sales by over US$1 million per longwall panel.

5.1.2.5 Operations Benefits

The proposed power, heat, and drilling project would reduce ventilation system demands and improve mine safety. With improved methane capture efficiencies, required mine airflow rates for dilution of methane during coal production will be reduced. Reduced airflow rates resulting in reduced mine pressure differentials will help minimize spontaneous combustion. With improvements to drainage efficiency, mine fans may potentially operate at less acute blade angles or at reduced rotational speeds, reducing power demands and, therefore, ventilating costs. Furthermore, reduced emissions into active mine workings will decrease the potential of explosive air-methane accumulations underground, particularly at working faces where the potential for ignition due to frictional sparking is greatest. This report does not quantify these benefits.

5.1.2.6 Environmental Fees

If the National Fund is to participate in the project as an equity partner, it could potentially use its dividends to offset the Wesola Mine's environmental fees. This arrangement needs to be verified and approved by the State Treasury.

5.1.3 Benefits to ZEC

This report proposes that the power, heat, and drilling project compensate ZEC for its increased heat generating costs resulting from firing its hot water boilers with coal rather than cofiring with coalbed methane. The project reimburses ZEC by selling its heat, up to 104,000 GJ per year, to ZEC for resale at significantly below market prices. The margin earned by ZEC from resale of the heat is sufficient to more than offset ZEC's increased generation costs. Also, the volume of heat produced by the project is sufficient to supply ZEC's market heat demands during some summer months, which would allow ZEC to curtail summer costs and realize increased savings.

5.1.4 Benefits to the USB Coal Mining Industry

The proposed project recommends the involvement of ZOK, a recognized gas drainage service company in the USB. ZOK's experience and contacts in the basin, its ability to carry out drilling operations at any mine, and the applicability of directional drilling to develop in-seam or horizontal gob boreholes at other mines in the basin, will serve to expand the mine degasification field in the region. As indicated in Section 2.2.6, directionally drilled horizontal gob boreholes could be applied at a number of other mines in the USB to offset overlying degasification galleries.

5.1.5 Environmental Benefits

Table 5.1 summarizes the estimated additional annual methane emissions mitigated by this project if it were operating today and in the year 2000, assuming that (1) ZEC gas demands remain at 1996 levels and (2) the overall methane drainage efficiency increases by five percent per year. The table includes equivalent CO_2 emissions based on a global warming potential of methane of 21 times that of CO_2 over a 100-year time frame (IPCC,1996). Cumulatively, the project will mitigate in excess of 44 Mm^3 of methane, or the equivalent of approximately 630,000 tonnes of CO_2.

Year	Methane Liberated (m^3)	Used by ZEC in 1996 (m^3)	Additional Emissions Mitigated by Project (m^3)	Additional CO_2 Mitigated by Project (tonnes)
1996	44,930,770	4,778,883	3,072,561	43,749
2000	49,879,440	4,778,883	4,781,361	68,080

Table 5.1: Additional Methane Emissions and Equivalent CO_2 Mitigated by Proposed Project

The use of CMM to generate 2.4MWe of power and over 100,000 GJ of heat per year will also result in reduction of CO_2 and local air pollution emissions normally associated with coal burning. At maximum operating capacity, the proposed project will annually displace approximately 10,500 tonnes of coal combusted for power generation at the local power plant. Table 5.2 presents the project's annual reductions in the emissions of CO_2, SO_2, NO_X, and particulates associated with the displaced coal. The table accounts for a net increase in coal consumption by ZEC to offset the displaced CMM.

Pollutant	Annual Reduction (tonnes)
CO_2	18,108
SO_2	127
NO_X	50
Particulates	548

Table 5.2: Global Environmental and Local Air Quality Impacts of Displaced Coal.

5.2 Project Risks

Every project will encounter some risk at each stage of its evolution. During the development phase, the developer will perform due diligence to give assurance that the project has no fundamental flaws. Before project financing is completed, both the equity and debt providers will conduct their own due diligence to ascertain that all uncertainties have been resolved and that the project faces no unforeseen risks. Finally, owners and investors commonly purchase insurance to compensate for certain insurable, unpreventable events, some of which are known as *force majeure* events.

The following sections summarize some of the more important risks that may concern the Wesola project's stakeholders.

5.2.1 Permitting Risk

This report discusses the requirement to obtain approvals to import horizontal directional drilling equipment into Poland. The Polish Higher Mining Authority will likely approve the equipment upon review of sufficient documentation, and after equipment testing, but there is uncertainty regarding the timeliness of the approval process. Approval delay will impact the project schedule. The developer must be convinced that equipment approval is certain before going ahead with costly development work. To facilitate approval and maintain schedules, the developer and project participants (ZOK or the Wesola Mine) must liaise appropriately with the approving agency.

5.2.2 Financing Risk

Financing risk includes the risk of not being able to assemble an investor and lender group whose members can agree on the equitability of the project structure, the distribution of risks, and debt and dividend payout schedules. The developer, who must accept the financing risk until financial closing, can mitigate the possibility of failure by writing a sound and equitable financing plan and providing the potential investors with a firm letter of intent for each critical agreement that underlies the project.

5.2.3 Gas Risk

The proposed project depends on a steady and predictable supply of drained CMM from the Wesola Mine throughout its economic life. Using existing mine records, investors and lenders need to assure themselves that the gas resource will be present in the coal reserves that Wesola plans to mine. They will also need assurance that the mine will continue to implement a system of methane drainage, and that that system will recover CMM according to the schedules set out in the project plan. This means that the project will contract with the Wesola Mine to accept the gas risk by assuring, to the extent possible, an adequate CMM flow to the cogeneration plant.

5.2.4 Construction Risks

Risks of cost overruns and schedule delays face the project developer during the construction phase. Construction projects experience cost overruns and delays because of design faults, equipment availability problems, unforeseen equipment importation issues, contractor-related disputes and issues, labor problems, and uncontrollable (e.g., climate) and *force majeure* circumstances. The project participants can minimize construction risks with duediligence during engineering design, procurement, and contractor selection, and by effectively managing the construction project.

5.2.5 Market Risk

The two elements of the proposed project (drilling and cogeneration) must have firm commitments in place to accept and pay for their services and products. The drilling project must have enough firm drilling agreements to assure investors there will be sufficient revenue to amortize the equipment. The cogeneration project must have letters of intent to purchase its electric and thermal products, thus transferring market risks to the purchasers. To accomplish this, energy purchase agreements would have “Take-or-Pay” clauses, committing the purchaser(s) to pay for energy products whether or not they take delivery. The Take-or-Pay agreements with the Wesola Mine and ZEC would provide incentives to the mine and the Katowice Holding Company by reinforcing their commitment to assure the gas supply, thereby minimizing the gas risk described above.

5.2.6 Mine Closing Risk

The mine closing risk combines elements of both gas and market risks for the proposed project because the mine is the supplier of gas and the market for power. Certainly, if coal industry restructuring is well underway before the project goes to financing, Wesola's future will be relatively secure. But if the mine were to close for any reason, the cogeneration project would cease to function. Investors might be able to salvage the tangible parts of the asset base by moving the plant to another site. However, such an event would inflict severe losses on the project. Investors would have to develop a new project, install the equipment at the new site, close the Wesola operation, and forego revenues during the transition period. If potential investors perform due diligence before restructuring, they should review all information available on the Wesola Mine's economic status and its reserve base relative to other mines in the USB. Investors must assure themselves of the mine's ability to remain open during the period of the project loans.

5.2.7 Technical Risk

Technical risk relates to the systems and equipment components the project plans to use for horizontal directional drilling and the cogeneration plant. The horizontal directional drilling equipment specified herein for the project has a long and successful record of performance in coal mines throughout the world. One area of potential concern that can be characterized at the outset, however, relates to the geological and stress conditions at the Wesola Mine. Project participants must consult with experienced Wesola Mine and ZOK personnel and develop drilling plans at locations where directional drilling has a high liklihood of success so as to assure that the drilling rates assumed in this report can be achieved in the USB with experienced personnel.

The technical risks associated with the cogeneration system mainly concern adherence to gas delivery quality and quantity specifications. A gas turbine is able to handle a wide range of gas quality (expressed as percent methane in air) and can accommodate most quality swings automatically. It is less able to be effective if gas flows fluctuate often so that the unit has to run part-load for a significant percent of operating hours. The plant designer needs to take special care that the mine degasification system can meet minimum delivery standards set by the project. Project planning done for this report specified a turbine-generator size with a fuel demand that would exceed projected gas supply only in the first few years. The question of fuel supply and unit sizing will undergo much more thorough analysis during project design phase, so an optimum turbine size might be different from the one described herein. Also, the preliminary capital budget calls for a gas storage (surge) tank that is capable of smoothing out gas flow fluctuations for short periods. Designers should revisit the size and operating mode of the surge system to minimize the effects of short-term gas flow swings.

6.0 REFERENCES

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ATTACHMENT 1

Wesola Mine Degasification Costs

Wesola Mine Degasification Costs

The following estimates supported the cost analysis:

- Typical longwall panels are 200 m in width and 1200 m in length
- Two angled gob boreholes are spaced every 30 m along the degasification gallery
- The total cost of labor, including benefits, and workers compensation insurance at twice the employee salary

The following data were provided by Wesola Mine personnel for this effort:

- The wage of laborers, except working face labor, equals 6.75 PLN (US$2.47) per hour
- The cost of casing and wellhead equipment for one average length (140 m) gob borehole would be 680 PLN (US$250)
- The time required to drill one average length 90 mm diameter gob borehole (140 m) is 15 shifts
- The cost of gathering lines on a diameter basis equals 17 to 67 PLN (US$6 to $25) per meter of length
- The cost of mining the 416 level on a per-meter basis is 2,400 PLN (US$880)
- Typical longwall productivity in the gassy area equals 1,875 tonnes per day

The following calculations assume an exchange rate (current in the spring of 1997), of 2.73 PLN per US dollar. By the end of the year the rate had risen to over 3.5 PLN per US dollar.

- Galleries: The Wesola Mine develops one gallery 1,000 m in length per longwall panel in the 416 low quality coal seam. Additionally, galleries between panels are interconnected. These are 250 m in length and equivalent to the width of a panel plus the width of the headgate and tailgate entries. The estimated cost of development is 3.0 M PLN, or US$1.1 million (1,250 m X 2,400 PLN per m). Assuming that the Wesola Mine blends the 416 coal with higher quality coal (3 to 1 ratio), the amount of clean coal mined in construction of the gallery is 7,313 tonnes per panel (1,250 m X 1.5 m X 4.0 m X 1,300 kg/m^3 X 0.75). Using the average market price of 65 PLN per tonne per year (Nasz Holding 1994), the estimated revenue from coal sales equals 475,300 PLN, or US$174,100. We estimate that the Wesola Mine's net cost for developing degasification galleries in the 416 seam per longwall panel is 2.5 M PLN, or approximately US$0.9 million.

- Boreholes: Assuming that the Wesola Mine develops boreholes along the longitudinal axis of the panel only, approximately 60 boreholes (1,000 m / 30 m X two boreholes), averaging 140 m in length, are required. We estimate development costs as follows:

  Labor - using a three-person crew, the cost of developing one borehole is 5,103 PLN (15 shifts to drill + three shifts to case, complete and connect X 13.5 PLN per hour X seven hours per shift X three men). Coupled with the cost of casing material and wellhead equipment, the estimated cost to develop one complete average length gob borehole is 5,783 PLN, or US$2,120.

  Drilling Consumables - assuming that one bit can be used to drill two boreholes at a cost of US$600 per 90 mm bit, and doubling this cost for bearings, oil, and other consumable drilling items, we estimate the total cost for drilling consumables at US$600 per gob borehole.

  Depreciation - assuming a depreciable basis of US$120,000 for the drilling equipment and using straight-line depreciation at 17 percent per year as per the Ordinance of Ministry of Finance, January, 1995, we estimate depreciation expenses at US$410 per borehole (0.17 X US$120,000 / 250 working days X 5 working days to drill one average length borehole).

Equipment Maintenance - assuming that the drilling equipment is down for maintenance 4 weeks per year, we estimate maintenance costs, including labor at US$1,380 (2 laborers X 7 hours per shift X 13.5 PLN per hour X 5 shifts per week X 4 weeks) per year, and replacement parts at US$20,000 per year, or US$430 per borehole (US$21,380 / 250 working days X 5 working days to drill one average length borehole).

Property Insurance - assuming that the drilling equipment value is the depreciable price, we estimate an average insurance cost of US$80 per borehole.

Other Costs - we assume an additional US$100 per borehole for other expendable items not included above.

Total Costs - as summarized below we estimate that the Wesola Mine's costs for developing 60 angled boreholes per panel are approximately US$224,400.

Cost Component	Cost per Borehole US$	Cost per meter US$
Labor	2,120	15.14
Drilling Consumables	600	4.30
Depreciation	410	2.90
Maintenance	430	3.05
Insurance	80	0.60
Other Costs	100	0.70
Total	3,740	26.69

Cost Summary for Angled Gob Borehole Development

- <u>Gathering Line</u>: Assuming that a 159 mm diameter pipeline connects between wellheads to gather and transport gas from the boreholes, we estimate that the capital and installation costs for the gathering system is 56,000 PLN, or approximately US$21,000. These figures are based on 25 PLN per meter, three men at 13.5 PLN per hour, seven-hour shifts, 50 m of pipe laid per shift, and a total of 1,000 m of four m lengths of steel pipe.

- <u>Gathering System Maintenance</u>: We estimated these costs on a per longwall panel basis using typical gassy area production rates and maintenance needs for a 60 borehole degasification system. Using the average coal production in the gassy area of 1,875 tonnes per day, and assuming an average 3.0 m longwall face height for the 501 and 510 seams, a typical panel is mined in 1.7 years using 250 work days per year. Inspection and maintenance costs for the 60 boreholes are estimated at 40 k PLN assuming one man shift per day at 13.5 PLN per hour, a 7 hour day, 250 work days per year X 1.7 years. This is approximately US$14.8 k.

- <u>Total</u>: We estimate that the total cost of the gallery degasification system is 3.17 M PLN, or approximately US$1.16 million per longwall panel. This cost is 1.86 M PLN or US$685,000 on a per panel, per year basis (3.17 PLN / 1.7 years per panel using the average production rate in the gassy area).

ATTACHMENT 2

CASE STUDY ILLUSTRATING THE APPLICATION OF HORIZONTAL GOB BOREHOLES AT A MINE IN THE UNITED STATES

CASE STUDY ILLUSTRATING THE APPLICATION OF HORIZONTAL GOB BOREHOLES AT A MINE IN THE UNITED STATES

Case Study

The Cambria 33 coal mine, which exploits the Lower Kittanning coalbed in the Appalachian Basin, developed nine horizontal gob boreholes over longwall panels. The cumulative length of these boreholes is 4,877 m, with longest individual lengths exceeding 700 m. Figure A2.1 presents plan and profiles of the boreholes over the outline of the longwall panels. The miners aimed the boreholes at the tension zones at the ends of the panels and over the return entries to take advantage of the low pressure influence of the mine ventilation system on gob gas migration. They experimented with various horizontal targets to assess borehole performance.

Figure A2.2 illustrates the stratigraphic sequence immediately above the mined seam. It shows horizontal boreholes developed into the C seam indicated on the figure, 6 m below that seam, and 6 and 12 m above the B seam. In order to overcome difficulties with water accumulation in low borehole elevation areas and to minimize separation requirements at the wellhead, the drillers steered the boreholes at a consistent downgrade once they passed the desired horizontal target.

Because this study was experimental in nature, the mine installed cross-measure boreholes (along the headgate of one of the panels), and vertical gob wells in addition to the horizontal gob boreholes. This combination enabled them to assess relative system performance. For example, they shut-in vertical gob wells for short periods of time to assess performance of the horizontal gob boreholes.

The following general conclusions resulted from this analysis:

- For the panel section with both cross-measure and horizontal gob boreholes, horizontal gob borehole production rates were five times that of the cross-measure boreholes.
- Higher production rates occurred over the tension zones alongside the tailgate entries.
- Boreholes targeted to just below the C coal seam (30 m above mining level), recovered methane at higher concentrations and greater rates and remained intact when under-mined.
- Horizontal gob boreholes effectively shield the mine ventilation system from gob gas migration because they generate a low pressure zone above the longwall gob.
- Vertical gob well shut-in tests indicated that the horizontal boreholes were as effective as the combined system (vertical and horizontal) at reducing gob gas emissions into the tailgate return airway.

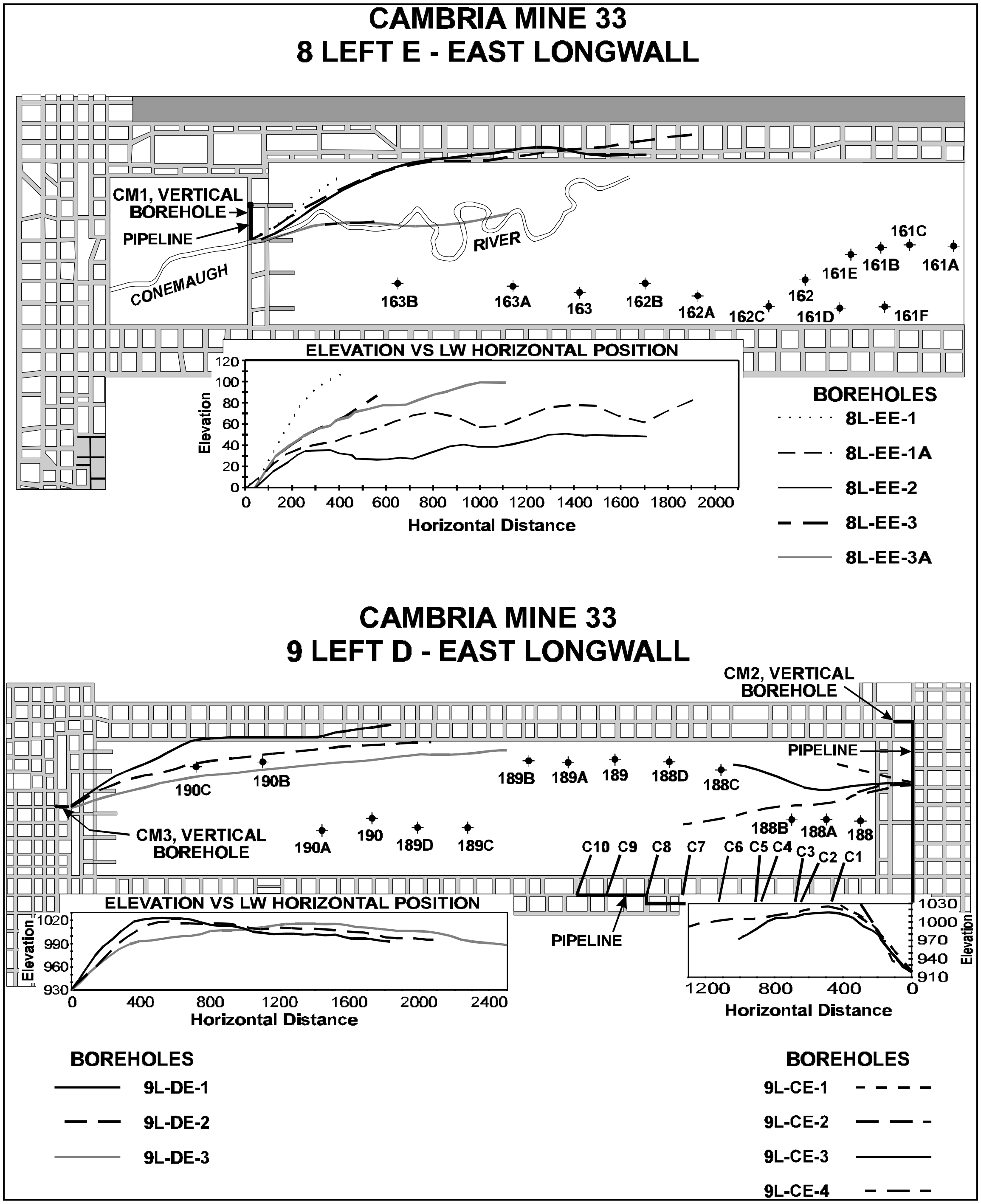


Figure A2.1: Plan View of Horizontal Gob Wells Developed at the Cambria 33 Mine (Dimension in US Units)

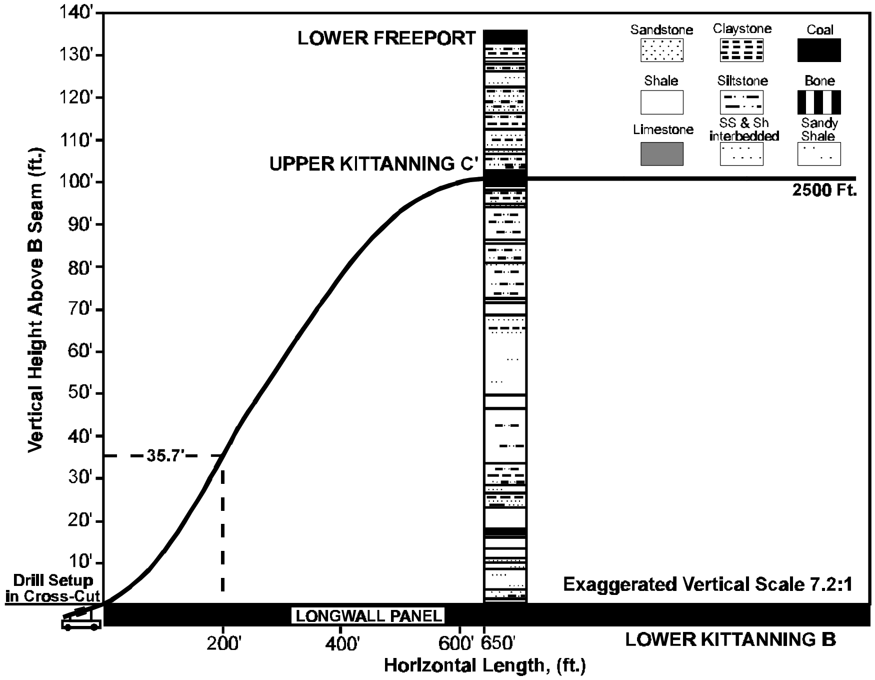


Figure A2.2: Stratigraphic Sequence Above the Mined Seam at the Cambria 33 Mine. (Dimension in US Units)

ATTACHMENT 3

Downhole Directional Drilling Equipment

Downhole Directional Drilling Equipment

Steerable Downhole Motor Assembly

Independent bit rotation is achieved without rotation of drill rods with downhole motors. A positive displacement hydraulic motor rotates the bit with high pressure water provided through the drill rods. The motor consists of a 4 m long helical rotor fitted inside a high density rubber lined stator. Most of the water discharges to facilitate cuttings removal just behind the bit, and the remainder flows to the front of the bit to assist in the cutting process. Performance specifications of a typical downhole motor are summarized in the table below.

1-2 Stage Downhole Motor Performance Specifications (60 mm)	
Water Pressure Requirement	4.8 MPa
Water Flow Rate	2 to 4 l/s
Rotational Speed	550 to 1370 rpm (for range of flow above)
Torque	108 Nm
Power	6 to 16 kW (for range of flow above)
Diameter	60 mm
Weight	81 kg

Downhole Motor Performance Specifications

Boreholes are steered by orienting a bent housing or shoe installed ahead of the downhole motor as shown on Figure A3.1. Desired borehole trajectory (azimuth and pitch) is attained by orienting the bent housing to exert a side force against the borehole wall opposite to the intended bit direction.

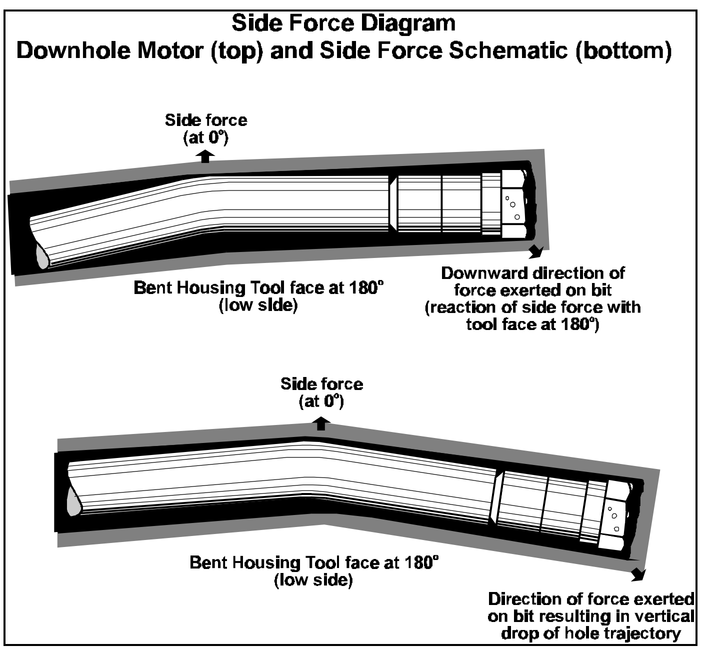


Figure A3.1: Downhole Steering Tools

Downhole Surveying System

Two general types of permissible borehole survey systems are available for use with longhole directional drilling equipment. The first provides on-request electronic directional data while drilling, the second involves a manually inserted downhole compass and camera. This report presents the latter system because of its favorable reliability and durability characteristics, necessary for import equipment. A single shot camera survey system provides driller's borehole azimuth, pitch, and tool-face orientation. Operators pump this permissible wireline survey tool within the drill rods to the back of the down-hole motor. At a pre-set time the camera photographs the bearings indicated by an integrated compass. Operators retrieve the camera with the wireline system after exposure and remove the film disk for developing. Surveying time varies from 10 to 20 minutes depending upon hole depth. Figure A3.2 shows a developed film disk from a single shot survey.

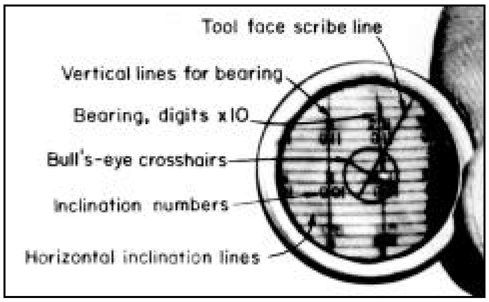


Figure A3.2: Developed Single Shot Survey Disc

Drill String

Sections of BQ wireline (3 m sections), flush joint, drill rod (56 mm diameter), comprise a typical directional drilling drill string. Operators use nonmagnetic rods (stainless steel or copper beryllium), for the first three to four sections behind the downhole motor to eliminate magnetic interference from the drill string during surveying.

Drill Bits

Typically operators use 76 mm diameter bits with the BQ rod assembly described above. Bit selection must consider the rotational speed and torque produced by the downhole motor. Drillers use various bits with polycrystalline diamond cutter (strata-pax), polycrystalline chip (geoset), and impregnated diamonds, depending upon coal or rock characteristics (hardness and friability). The bits are designed so that the drilling fluid pressure drop across the bit is minimized to provide maximum fluid pressures to drive the downhole motor. Operators use a range of bit types during initial horizontal gob borehole development and selectively optimize the downhole configuration to maximize the penetration rate.

ATTACHMENT 4

Information for Foreign Producers

Higher Mining Authority
Katowice, 17 July 1995

Information for Foreign Producers
on the procedure of approving machines, devices and materials
to be used in the Polish mining industry
[Translated from Original Polish Text)

This information defines the procedure to be followed by the foreign producers of machines, devices and materials during the process of their approval to use in the mining industry (according to regulations in force since 2 September 1994).

1. The requirement of approving (licensing) machines, devices, and materials as well as explosives and related equipment before their use in the mining enterprises derives from the provisions of Article III of the Act of 4 February 1994, entitled *Geological and Mining Law*, published in the *Dziennik Ustaw Rzeczypospolitej Polskiej* of 1994, No.27, item 96. The types of machines, devices and materials as well as explosives and related equipment must be approved for use in the mining enterprises along with the approval procedure, have been defined in the decree issued by the Prime Minister on 24 August 1994, and published in the *Dziennik Ustaw Rzeczypospolitej Polskiej* of 1994, No. 92, item 434. The approval decision related to machines, devices and materials as well as explosive materials and equipment is issued by the President of the Higher Mining Authority in Katowice. This decision confirms that the subject of approval meets the requirements of work safety and hygiene as well as fire safety requirements that are defined by the obligatory regulations and standards in force in Poland, according to the decree by the Minister of Industry and Trade (in accordance with the Acts published in the *Dziennik Ustaw Rzeczypospolitej Polskiej*). The approval decision can be issued as a result of an application submitted by the producer or his plenipotentiary representative who has the office in the territory of Republic of Poland. The above mentioned decision shall be obtained before the product is sold to the Polish user. The approval obligation refers to any machines, devices or materials defined in §2 of the above mentioned decree by the Prime Minister, dated 24 August 1994. During the approval procedure the machines, devices, or materials are subject of the attestation research carried out by attesting institutions pointed out by the President of the Higher Mining Institute. Before the approval procedure related to machines, devices, or materials to be used in mining industry is started or in the situation of any difficulties, necessary comments and detailed information can be obtained from the appropriate representatives of the Higher Mining Authority. Names of those representatives and their phone numbers are listed in the Appendix to this information.

2. The approval process related to machines, devices, or materials to be used in the mining industry comprises the following:

    - Producer's application to the President of the Higher Mining Authority for pointing out the institutions that shall issue the attesting opinions

    - Pointing out by the President of the Higher Mining Authority the institution(s) that should issue the attesting opinions, each one in the determined range

    - Research on the compliance of the product with the standards introduced as obligatory Polish Standards and relevant legal regulations; technical and operational documentation, references, laboratory and on-site examination results, and approval documents issued by the mining authorities in the producer's country; production quality control systems used by the producer

- Research connected with work safety and hygiene, fire safety and rules of ergonomy, carried out at the on-site research stands

- Application of the producer to the President of the Higher Mining Authority to issue approval document for the machine, device, or material to be used in mining industry

- A decision by the President of the Higher Mining Authority to approve the machine, device, or material to be used in the mining industry and issuing approval mark

- Optionally, obtaining an attestation opinion and decision permitting the introduction of design changes in the machines, devices, and materials approved for use

1. The producer shall attach the following appendices to the approval application related to machine, device, or material:

    a) Documents and documentation defined in §4 (taking into account the provisions of §7), of the a/m decree

    b) Attestation opinions issued by the institution(s) pointed out by the President of the Higher Mining Authority. Every attestation opinion shall comprise explicit assessment of the machine, device, or material regarding its compliance with the regulations on work safety and hygiene as well as on fire safety that are determined by the obligatory standards and regulations in force in the Republic of Poland

    c) Treasure Fee in the form of Treasure Stamps; the amount of this fee is determined by the provisions of the decree by the Minister of Finance, issued on 26 June 1992, published in the *Dziennik Ustaw Rzeczypospolitej Polskiej*, 1992, No. 53, item 253 with later amendments published in *Dz. U.*, 1993, No. 56, item 261, *Dz. U*, 1993, No. 64 item 307 and 1994, No.115, item 555.

    The documentation and opinion attached to the application or the attestation opinions should be issued as a bounded (tied) issue, in two copies in a way that will prevent the particular sheets (text and drawings), from accidental removal from the sewed and plumbed unit copy, and shall be stamped and signed by the attesting person from the authorized attestation institution (this also refers to the attached drawings and calculations), in order to demonstrate that this is the documentation being the base for research and that the possible amendments are introduced under the agreement or request of the attesting person.

2. The attestation institutions carry out the research on condition of payment, based on the order from the producer or his plenipotentiary representative in Poland. The attestation research comprises the assessment of the machine, device, or material related to the requirements on work safety and hygiene and fire safety. This assessment is carried out based on the submitted technical and operation documentation and on the results of laboratory and on-site research (including examinations on research stands). The methods and range of the laboratory and on-site research shall include only research that is necessary for the a/m assessment. The attestation institutions can accept the research results submitted by the applicant and carried out in laboratories located out of the territory of Poland. This especially applies to the situations in which the Polish attestation institutions have signed cooperation agreements with the foreign attestation institutions related to mutual acceptance of the comparable research results.

3. In case of introductory changes in the machines, devices, or materials that have previously been approved in the mining enterprises, one shall distinguish changes that significantly impact the

work safety level. Such changes include the changes listed in the §12 of the a/m decree by the Prime Minister of Poland.

a. Introduction of the a/m changes causes the necessity of obtaining the approval issued by the President of the Higher Mining Authority. The procedure is the same as described in paragraphs II. 1 and II. 2, relevant to the range of the introduced changes.

b. In case of introducing changes in the machines, devices, and materials that have previously been approved for use in mining enterprises, and which do not significantly impact the work safety and hygiene and fire safety, the decision issued by the President of the Higher Mining Authority is not required. It is however necessary to inform the Higher Mining Authority about their introduction in order to make supplements in the approval documentation.

b. The decision on whether the changes significantly impact the work safety and hygiene and fire safety of machines, devices and materials is made by the producer.

4. Additional comments and information.

a. The decision issued by the President of the Higher Mining Authority related to the approval of a machine, device, or material does not comprise assessment of the product in terms of any other requirements important to the user (e.g., product price, working ability, lifetime). These are the elements of market behavior and therefore are not subject to the Higher Mining Authority activities.

b. The decision issued by the President of the Higher Mining Authority related to the approval of machines, devices, and material for use in mining enterprises expires under law: 1) in case of any hidden failures in the subject of approval (product) and 2) in case of worsening the quality or omitting the conditions determined in the decision itself and which might be harmful in terms of work safety and hygiene and environmental protection during the operation of the mining enterprise. The Higher Mining Authority reserves the right to order the authorized attestation institution to examine, on charge of the producer, a previously approved machine, device, or material in order to check whether the machine, device or material meets the approval requirements and the parameters of the piece that is the subject of attestation research.

c. Due to a lack of mutual agreements between the Higher Mining Authority in the Republic of Poland and relevant institutions in the producer’s countries related to mutual acceptance of approval decisions, the fact of having such decision in another country does not authorize its acceptance, and causes the necessity of initiating approval procedure in Poland.

Directory
of the Higher Mining Authority Officers
who provide information on the issues of
machines, devices and materials approval

1. Power-Mechanical Department:

1. mar inz. Marian **Mazur**	Head of Department, ext. phone 116
2. mar inz. Stanislaw **Budzowski**	Deputy Head of Dpt, ext. phone 126
3. mar inz. Miroslaw **Zapart**	Deputy Head of Dpt, ext. phone 128

2. Mining Department:

1. mar inz. Roman **Starosielec**	Head of Department, ext. phone 267
2. mar inz. Wojciech **Magiera**	Deputy Head of Dpt, ext. phone 115
3. mar inz. Antoni **Mueller**	Deputy Head of Dpt, ext. phone 117

Attachment 5

Directional Drilling Costs

Directional Drilling Costs

Development of Drilling Site

Assuming a drill site of dimensions 3m W X 2.5m H X 7m L is required and is constructed as an alcove off a main entry, development costs of 28,000 PLN, or US$10,250 are estimated. This is based on 533 PLN per cubic meter calculated from 2,400 PLN per meter for development of 1.5 m X 3 m degasification gallery.

Wellhead Equipment and Casing

Procurement costs for horizontal borehole wellhead materials (gas/water separator, valves, monitoring and measuring system) are approximately US$4,500. Assuming that these materials can be procured in Poland, estimated Polish costs are US$3,600 (assuming 80 percent of US costs).

Directional Drilling

United States directional drilling contractors charge between US$65 to US$95 per meter for drilling in rock (overlying strata). Labor costs, including employee benefits, typically account for between 40 and 50 percent of the costs of drilling. Assuming a profit margin of 15 percent, other costs of sales (equipment depreciation, maintenance, expendable materials, and insurance) range between US$35 and US$50 per meter. Noting that labor and benefits rates for similarly trained technicians in Poland are approximately 35 percent of those in the United States, comparable directional drilling rates charged by contractors in Poland would range between US$50 and US$70 per meter for drilling in rock. For the cost analyses presented in this report we use a rate of US$50 per meter. An estimate of actual costs for a Polish directional drilling contractor is presented below:

Operating Costs for Drilling Unit

Component	Value	Basis		
Drilling Performance				
Drilling Advance Rate (m/shift)	32	Average rate for drilling in rock		
Drilling Shifts Per Year	425	2 shifts/d X 250 d/year X 75% availabilitiy		
Meters Drilled Per Year	13,600			
Drilling Costs	**Value**	**Basis**	**Annual Cost**	**Costs per Meter**
Manager with Benefits ($/hr)	$ 20.00	Professional Rate X 1.48	$ 40,000	$ 2.94
4 Laborers with Benefits ($/hr)	$ 44.00	Technician Rate X 1.48	$ 88,000	$ 6.47
Direct Expenses ($/hr/man)	$ 5.00	$5 per hour per laborer	$ 40,000	$ 2.94
Consumables ($/m)	$ 15.00	$ 15.00 per meter	$ 204,000	$ 15.00
Insurance ($/yr)	$ 12,000	Liability and Property	$ 12,000	$ 0.88
Depreciation ($/yr)	$ 49,600	Equipment Amortized over 20 yrs	$ 49,600	$ 3.65
Maintenance and Repair ($/yr)	$ 75,000	Parts and Outside Labor	$ 75,000	$ 5.51
General and Administrative* ($/yr)	$ 12,000	G&A from above table *0.5	$ 12,000	$ 0.88
Totals			$ 520,600	$ 38.28

* Assumes some General and Administrative also supported by ZOK or Wesola Mine

ATTACHMENT 6

Vendor List, Drilling Equipment

Vendor List, Drilling Equipment

Equipment	Vendors
Longhole Drilling	J.H. Fletcher & Co. P.O. Box 2187 Huntington, West Virginia 25772 USA TEL: 304 525-7811 FAX: 304 525-3770
Longhole Drilling	Acker Drill Company, Inc. P.O. Box 830 Scranton, Pennsylvania 18501 USA TEL: 717 586-2061 FAX: 717 586-2659
Downhole Directional Drilling	Directional Drilling Services 4446 West 1730 South Salt Lake City, Utah 84130 USA TEL: 801 972-3333 FAX: 801 974-1084
Rods and Bits	Directional Drilling Services 4446 West 1730 South Salt Lake City, Utah 84130 USA TEL: 801 972-3333 FAX: 801 974-1084
Rods and Bits	Boart Longyear 2340 West 1700 South Salt Lake City, Utah 84127 USA TEL: 801 972-6430 FAX: 801 977-3373
Drill Rods and Tools	MINEX Inc. 194 Arden Drive Belgrade, Montana 59714 USA TEL: 406 388-1776
Drill Bits	Moab Bit and Tool Co. 995 West 4th North Moab, Utah 84532 USA TEL: 801 259-7763 FAX: 801 259-2968

ATTACHMENT 7

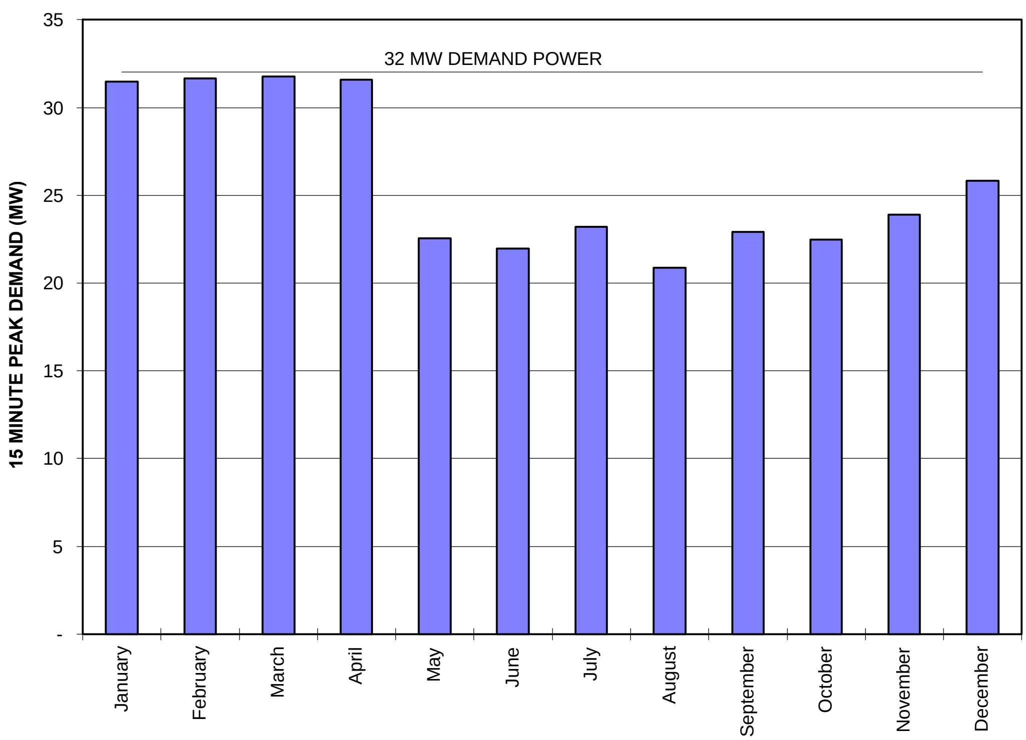
Wesola Mine Power Analysis for 1996

Wesola Mine Power Analysis for 1996

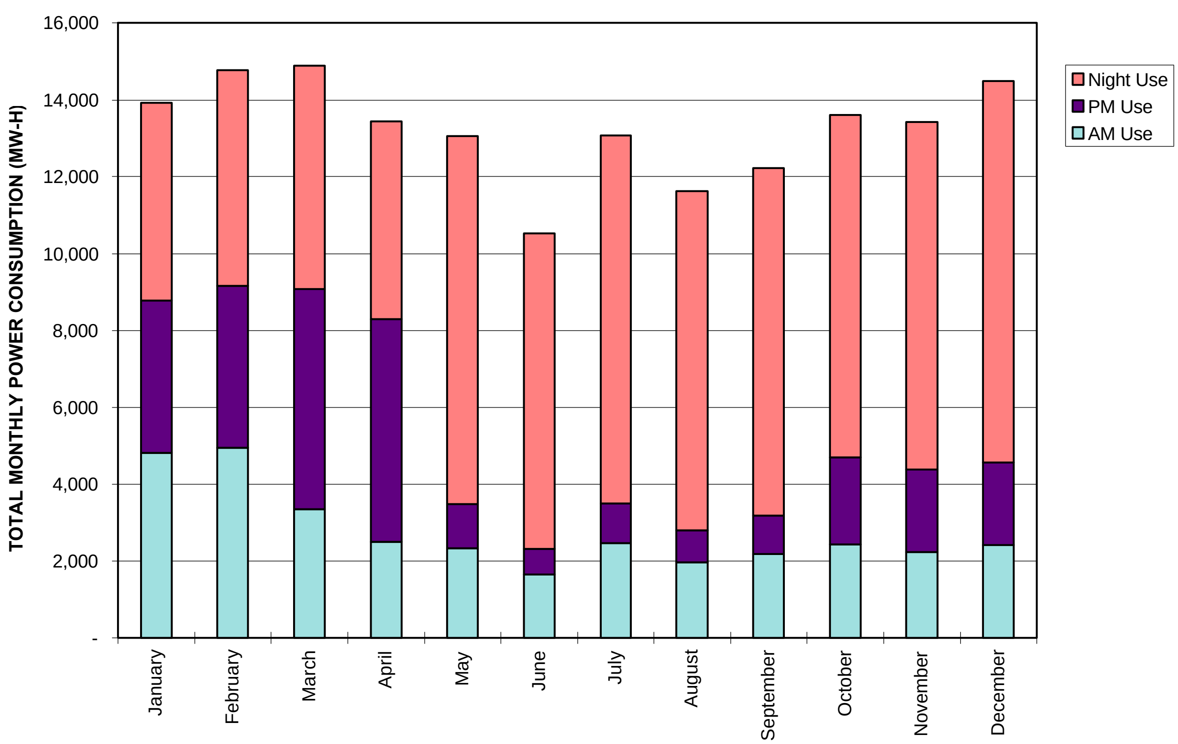
WESOLA POWER DEMAND															
Months		January	February	March	April	May	June	July	August	September	October	November	December	Totals	TWA
Days Per Month*	(Days)	31	28	31	30	31	30	31	30	31	30	31	30	364	
Demand Power	(MW)	32	32	32	32	32	32	32	32	32	32	32	32	384	
Cost of Demand	$ US	50,743	50,743	50,743	50,743	30,363	30,400	30,400	30,400	30,400	30,400	30,400	30,400	446,135	
Cost per MW	$ US/MW	1,586	1,586	1,586	1,586	949	950	950	950	950	950	950	950	-	1,162
15 Min Peak	(MW)	31	32	32	32	23	22	23	21	23	23	24	26	310	
Cost of Peak	$ US	82,078	82,508	82,870	82,344	35,243	34,330	36,261	32,610	35,776	35,162	37,414	40,508	617,106	
Cost per MW	$ US/MW	2,607	2,607	2,608	2,607	1,564	1,564	1,564	1,564	1,562	1,563	1,565	1,570		1,990
Peak AM	(MWh)	4,813	4,953	3,335	2,490	2,327	1,639	2,453	1,962	2,176	2,426	2,236	2,415	33,225	
Cost of Peak AM	$ US	257,837	265,358	178,688	133,405	116,003	81,693	122,246	97,792	108,450	99,873	92,057	99,420	1,652,821	
Cost per MWh	$ US/MW	53.57	53.58	53.58	53.58	49.85	49.84	49.84	49.84	49.84	41.17	41.17	41.17		49.75
Peak PM	(MWh)	3,959	4,213	5,749	5,806	1,148	674	1,033	839	1,000	2,258	2,144	2,154	30,977	
Cost of Peak PM	$ US	113,139	120,376	164,282	168,187	77,635	45,551	69,843	56,698	67,609	151,909	144,230	144,931	1,324,390	
Cost per MWh	$ US/MW-h	28.58	28.57	28.58	28.97	67.63	67.58	67.61	67.58	67.61	67.28	67.27	67.28		42.75
Night	(MWh)	5,159	5,597	5,807	5,143	9,579	8,217	9,591	8,813	9,040	8,916	9,046	9,920	94,828	
Cost of Night	$ US	92,133	99,960	103,711	92,061	216,968	186,121	217,251	199,633	204,774	183,450	186,134	204,110	1,986,306	
Cost per MWh	$ US/MW-h	17.86	17.86	17.86	17.90	22.65	22.65	22.65	22.65	22.65	20.58	20.58	20.58		20.95
Total Consumption	(MWh)	13,931	14,763	14,891	13,439	13,054	10,530	13,077	11,614	12,216	13,600	13,426	14,489	159,030	
Total Cons. Cost	$ US	463,109	485,694	446,682	393,653	410,606	313,366	409,340	354,123	380,833	435,232	422,420	448,460	4,963,518	
Average Cons Cost	$ US/MW-h	33.24	32.90	30.00	29.29	31.45	29.76	31.30	30.49	31.17	32.00	31.46	30.95		31.211
Total Cost	$ US	595,930	618,945	580,295	526,740	476,213	378,095	476,001	417,134	447,010	500,794	490,235	519,368	6,026,758	
Total Cost per KWh	$ US/kW-h	0.043	0.042	0.039	0.039	0.036	0.036	0.036	0.036	0.037	0.037	0.037	0.036	0.038	

Note: Power invoice periods do not always coincide with the number of days in a calendar month.

WESOLA MINE 1996 PEAK POWER DEMAND



WESOLA MINE 1996 POWER CONSUMPTION



ATTACHMENT 8

ABB Turbine Specifications

ATTACHMENT 9

Basic Differences between Limited Liability and Joint Stock Companies

Basic Differences between Limited Liability
(Sp. Z o.o.) and Joint Stock (S.A.) Companies

	Sp. Z o.o	**S.A.**
No. of founders	At least 1 person	At least 3 persons
Polish and foreign Minimum initial capital (zlotys)	4,000 zlotys (40 min old zlotys)	100,000 zlotys (1,000 min old zlotys)
Capital to be paid in prior to registration	100%	25%
Capitalization of pre-operational period costs	Not allowed	Max. 5-year write off
Capital increase requires General Assembly approval	66.7% votes	75% votes
Minimum number of Board Members	1	1
Supervisory Board or Auditing Committee	Either or both may exist (min. 3 members)	At lease one must exist (min. 5 members)
Obligatory reserve out of after-tax earnings	No	8%
Obligatory audit	Yes if: paying dividend abroad; size criteria are met	Always
General Assembly convenes if company bears loss	If loss exceeds reserve capital and 50% of share capital	If loss exceeds reserve capital and 33.3% of share capital
Earliest time after liquidation announced for distribution of assets	6 months	12 months
Notarial reports of General Assembly required	If company articles are altered	Always

ATTACHMENT 10

Discussion of Project Financing Options

Discussion of Project Financing Options

Presented below are a variety of sources of funds, ranging from small development grants to major loans. We have segregated them into categories: development funding, government project financing, and financing from commercial sources, although some agencies may provide both development funds and permanent financing. Additionally, excerpts from the USAID handbook entitled "Market for Financing of Environmental Investment Projects in Poland," are included as Attachment 11.

Project Development Funding Sources and Assistance

Within Poland several governmental and quasi-governmental funding sources have expressed the willingness to advise the project developer. There are also some foreign programs that may be interested in the project. Contact information is appended to this attachment.

Polish Oil and Gas Company (POGC)

Representatives of the POGC stated that some project development funding may be available if the proposed project fits their goals and if they can obtain an equity interest. They indicated that they would consider the longhole drilling and power and heat generation project proposed at the Wesola Mine.

USAID

USAID will provide in-kind assistance, e.g., contractual, legal, and technical consulting advice, and potentially some development funds for energy projects that meet their criteria. The proposed project at the Wesola Mine meets their general critiera: energy efficiency, American technology, replicability, and employment. Note that the USAID program in Poland will end in 1999.

Bank Ochrony Srodowiska (BOS)

The BOS Bank, the Bank of Environmental Protection, which manages the funds for the National Fund, works with the United States to develop projects through a development company called PAKTO. PAKTO, which has an agreement with EXIMBANK for funding support, has about US$3 to $30 million available for developing viable environmental related projects.

Joint Implementation Programs

Climate change is a global issue requiring internationally coordinated solutions. The United Nations Framework Convention on Climate Change (FCCC), encourages Joint Implementation (JI) to accelerate greenhouse gas reduction. JI projects are partnerships that coordinate interested parties from developed countries with projects in developing countries and countries with economies in transition. The first Conference of Parties of the FCCC in Berlin in 1995, authorized an international pilot phase of activities implemented jointly (AIJ) to gain practical experience and develop a working methodology for guiding future JI projects. The results of the pilot phase AIJ projects will guide post-2000 GHG offset credit commitments.

Countries such as the United States, Japan, Canada, the Netherlands, France, and Switzerland have active, multiple project AIJ programs which can provide grant assistance or concessionary finance for climate change projects such as the Wesola project. Germany also has a history of providing technical and financial assistance to Central and Eastern Europe.

United States. An Interagency Work Group, chaired by the U.S. State Department, is responsible for overall policy development on joint implementation. An independent technical review board of eight U.S. government agencies, the Evaluation Panel, reviews potential projects. The U.S. program offers technical assistance and facilitates investment in joint implementation projects and technologies. Two examples follow:

- Center for Clean Air Policy, Wisconsin Electric Power Company, NIPSCO Industries, Inc. (energy-based holding company), Unicom Enterprises (Edison Development Company), and City of Decin in the Czech Republic partnered in a coal-to-gas fuel switching project.

- Sustainable Development Technology Corporation, Oregon State University (OSU) , Sealweld Corp., GAZPROM, Center for Energy Efficiency, and the cities of Saratov and Pallasovka in Russia may join resources for a fugitive gas capture program (natural gas distribution system).

European countries such as the Netherlands, France, Norway, Switzerland, and Germany operate programs that grant concessionary finance for international projects, preferably with corporate participation or hardware from the donor country used in the project.

The Netherlands. The Dutch Foreign Ministry in the Hague manages the Joint Implementation Fund (JIF), which grants concessionary finance for international projects. As AIJ efforts do not yet involve commitment of credits, the JIF funds can also be used to leverage the project's financal structure to assure sufficient project return for the participants. Because of the geographical proximity and historic links between Poland and the Netherlands, the JIF program may enhance financing options for a CBM project in Poland.

France. The French Global Environment Facility (FGEF), a bilateral resource, uses grants to support projects which have a positive impact on the global environment. FGEF granted 13 percent of its resources in 1994 through 1996 to projects in Eastern Europe.

Norway. Norway partners with the World Bank by setting up bilateral AIJ demonstration projects in a number of regions, including fuel switching in Poland. (Specifically, Norway has teamed with Poland and the World Bank's GEF to finance the retrofit of district heating boilers from coal to gas and technical assistance after the conversion.)

Switzerland. The Swiss AIJ Pilot Program identifies potential projects through bi- and multi-lateral channels already in place for Swiss government cooperation with developing and Central and Eastern European countries.

Germany. Germany's AIJ agency provides technical assistance to Central and Eastern Europe.

Contact information for American and European JI programs is attached.

Private Sources

Often a project will interest an equipment supplier or a supplier of services because it represents a significant source of new business. The company may be willing to advance some limited development funds to help the project, on the condition that the company make its sale and that it is well reimbursed at closing. For the proposed project we identified the large turbine manufacturer, ABB. Note that private firms willing to assume the high risks of an undeveloped project expect to be rewarded at a high rate of return.

Project Financing: Polish Government Sponsored Sources

The proposed project at the Wesola Mine qualifies for Polish governmental assistance because of its strong environmental benefits. For these reasons part or all of the equity (including some in the form of a grant), and some debt will likely come from national or bilateral agencies. Some of the more promising sources of other equity and debt sources are discussed below.

ECOFUND

The ECOFUND is the institution that manages the "Polish Debt for Environment Swap"; approximately 10 percent of outstanding Polish debt lent by 16 countries in the 1970's which is forgiven if converted and spent on environmental projects. The fund gives highest priority to greenhouse gas mitigation projects, particularly those that will also promote US trade (the U.S. 10 percent contribution is the highest at US$370 million). The ECOFUND provides grants which may be up to 20 percent of commercial project financing, preferably to pay for equipment or technology. The ECOFUND is also willing to sign a conditional letter of intent early in the project development process to help the developer convince other capital sources of the validity of the project.

Additionally, equipment procured under ECOFUND grants can be exempt of import duties provided that it is imported from one of the lender countries that have agreed to the debt swap.

The ECOFUND management seemed very receptive to the proposed project and would be willing to be involved at the development stage. The fund accepts applications in March, June, and October of every year, and awards approximately US$30 million per year to about 15 percent of the applicants. About 20 to 25 percent of this funding is appropriated to greenhouse gas mitigation projects.

The ECOFUND selects projects based on economics, environmental benefit, and replicability. Projects for consideration must be economically viable with and without the grant, preferably with short pay back periods. The ECOFUND's priorities, selection criteria, and procedure are presented in Attachment 12.

National Fund

The National Fund is the principal institution responsible for defining and carrying out Poland's environmental policy under the auspices of the Minister of Environmental Protection. The National Fund is supported by fees and fines charged to industry for exploitation of the environment (9 percent of funding is from mines), and in return, provides grants, loans, and cash equity (with ownership position), to support environmental projects, specifically to support procurement of hard assets. In 1995 the fund supported over US$30 million in undertakings for environmental projects associated with mines.

Projects applying to the National Fund typically encompass more than one Voivodship, or implement new and innovative technologies not yet demonstrated in Poland. Projects that do not satisfy these categories can seek similar funding at the Voivodship level (The Voivodship Fund), while those that do, can actually apply at both agencies. The proposed project at the Wesola Mine should apply to both the Voivodship and National Funds as per discussions with fund managers.

The National Fund's preference is to provide loans with remission provisions (amounts from US$1.2 million to US$100 million) at favorable rates, about 6 percent below current commercial market rates. The National Fund can grant remission of up to 40 percent of the outstanding principal after 50 percent of it is paid if the project fullfills all of its environmental requirements and is implemented within the agreed upon period. Typical loan terms are 3.5 years. Additionally, the National Fund could also forgive environmental debts using dividends gained from project investments at the mine as stated previously.

Voivodship Fund

The regional counterpart to the National Fund has less money for projects but should also be approached with the proposed project. The Voivodship Fund provides similar funding and both indicate that a maximum contribution of 40 percent from both funds would be reasonable; 10 percent cash equity, and 30 percent debt. The cash equity would be secured by a 33 percent ownership position in the project.

Information on the National and Voivodship Funds, including contact information, can be found in Attachment 13.

Project Financing: Other and Commercial Sources

Polish Oil and Gas Company (POGC)

As indicated above, the POGC expressed an interest in the proposed project, particularly as it promotes technology for increased gas recovery (directional drilling). The POGC indicated that they would indicate their interest after review of feasibility analyses and if interested, would be able to provide cash equity for an ownership position.

Bank Ochrony Srodowiska (BOS)

As presented above, the BOS bank expressed an interest in the proposed Wesola Mine project and could provide both equity or debt with or without the involvement of PAKTO as previously discussed. Seventy percent of BOS loans are for environmental projects.

Joint Implementation Programs

In some cases the financial assistance coming from JI programs may amount to much more than development grants. (See JI discussion above.)

Commercial Banks

The Wesola project developer should also approach commercial banks, Polish banks and international banks that do business in Poland. We discussed the potential project with Citibank representatives and they indicated that they have provided many loans to coal mining operations in the Upper Silesian Basin. Contact information for commercial banks can be found in the AID Guide included as Attachment 11.

Summary

The table below summarizes the various types of funding sources discussed in this section. It also presents roles that the Wesola Mine and other participants might play in the financing structure.

Potential Source	Development Funds	Equity	Grant	Loan
POGC	Yes (if equity)	Yes	-	-
BOS Bank	-	Yes	-	Yes
PAKTO	Yes	Yes	-	-
JI Programs	Yes	Yes	Yes	-
Citibank		Yes		Yes
USAID	Small grants and in-kind services	-	-	-
ECOFUND	-	-	Yes	-
National Fund	-	Yes	-	Yes
Voivodship Fund		Yes		Yes
Wesola Mine	In-kind	In-kind	-	
ZEC	In-kind	In-kind	-	-
ZOK	In-kind	In-kind	-	-
ABB	Yes	Yes		Yes

Potential Sources of Funding for Proposed Project at the Wesola Mine

Contact Information

Polish Oil and Gas Company, Geological Office Geonafta

Mr. Marek Hoffmann, Director
76 Jagiellonska Street
03-301 Warsaw
Poland
TEL: (48-22) 11-26-06
FAX: (48-22) 11-28-78

U.S. Agency for International Development (USAID)

Maria Yakubowicz
email: mjakubowicz@usaid.gov
TEL: (48-22) 63-24-80
Warsaw, Poland

Bank Ochrony Srodowiska S.A. (BOS)

Mr. Jan K. Wielgus, Director
Capital Investment Department
ul. Przasnyska 6A
01-756 Warszawa, Poland
TEL: (48-22) 633-55-22
FAX: (48-22) 639-73-10

Joint Implementation Programs

American JI program:

Mr. Robert K. Dixon, Director
Ms. Ramola Gupta, Central Europe/Newly Independent States and Energy/Methane
United States Initiative on Joint Implementation
PO-63
1000 Independence Avenue, SW
Washington, D.C. 20585
(202) 586-3288 Telephone
(202) 586-3485 Facsimile

French JI program:

Ms. Catherine Garreta, Executive Secretary
Mr. Christian de Gromard, Greenhouse Effect and Ozone Layer
Secretariat du F.F.E.M
Caisse Française de Développement
35, rue Boissy D'Anglas 75379 Paris cedex 08
+33 1 40 06 32 55 Telephone
+33 1 01 40 06 32 48 Facsimile

Netherlands JI program:

Mr. Ard D. Kant
Fund Manager Joint Implementation
Division Climate, Energy, and Environmental Technology

Ministry of Foreign Affairs
Bezuidenhoutseweg 67
P.O. Box 20061
2500 EB The Hague, The Netherlands
31-70-3486057 Telephone
31-70-3484303 Facsimile

Norweigan JI program:

Geir Sjöberg
Royal Ministry of Foreign Affairs
PO Box 8114 Dep
0032 Oslo
Norway
+47 22 24 36 00 Telephone
+47 22 24 95 80/81 Facsimile

Swiss JI program:

Anne Arquit Neiderberger
Program Manager SWAPP
Federal Office for Foreign Economic Affairs
Effingerstrasse 1
CH-3003 Berne
Switzerland
+41 31 323 08 85 Telephone
+41 31 324 09 58 Facsimile

German JI program:

Mr. Franzjosef Schafhausen or Ms Annette Jochem
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
Division G I 16
Environment and Energy, Environmental Technology, Environment and Products
PO Box 12 06 29
D-53048 Bonn
Germany
+49 2 28 3 05 23 50 Telephone
+49 2 28 3 05 33 36 Facsimile

ABB Prvni brnenska strojirna Brno, Ltd. (ABB)

Mr. Mike Burgess
ABB Prvni brnenska strojirna Brno, Ltd.
Olomoucka 7/9
656 66 Brno. Czech Republic
TEL: 420 5 514-2602
FAX: 420 5 514-3013

ATTACHMENT 11

Excerpts from USAID's Guide:
"Market for Financing of Environmental Investment Projects in Poland"

ATTACHMENT 12

ECOFUND Polish Debt for Environmental Swap

ATTACHMENT 13

The National Fund for Environmental Protection and Water Management

ATTACHMENT 14

Details of Economic Analyses

Projected Turbine Performance

1996 Average Emissions	123,098
1996 Average Drained Volume	20,760
1996 Degas Efficiency	17%

Methane Emissions Projections for 10 Years

	Year	Drain Eff.	Projected Liberated	Drained	Turbine Load	Gen Eff	Elev. F	Losses	Gen	Heat	HWB (kWth)
			(cmpd)	(cmpd)		27.4%	%	%	kWe	kWth	40%
1	1996	17%	123,098	20,760	0.82	24.6%	0.97	0.9	1,748	6,392	2,556
2	1997	18%	126,488	22,398	0.88	26.0%	0.97	0.9	1,989	6,775	2,908
3	1998	19%	129,877	24,148	0.95	27.0%	0.97	0.9	2,223	7,208	3,250
4	1999	20%	133,267	26,017	1.00	27.4%	0.97	0.9	2,371	7,541	3,466
5	2000	20%	136,656	28,013	1.00	27.4%	0.97	0.9	2,371	7,541	3,466
6	2001	22%	135,389	29,141	1.00	27.4%	0.97	0.9	2,371	7,541	3,466
7	2002	23%	134,122	30,312	1.00	27.4%	0.97	0.9	2,371	7,541	3,466
8	2003	24%	132,854	31,527	1.00	27.4%	0.97	0.9	2,371	7,541	3,466
9	2004	25%	131,587	32,787	1.00	27.4%	0.97	0.9	2,371	7,541	3,466
10	2005	26%	130,320	34,095	1.00	27.4%	0.97	0.9	2,371	7,541	3,466

Heating Value Methane (100%)	32911.6	kJ/cm	
Total Turbine Fuel Required	26021	cmpd	
Fuel for Turbine	23861	cmpd	
Compressor Fuel	1550	cmpd	
Fuel Available from Vent	2160	cmpd	
Total Fuel Requirement	27571	cmpd	
Total Gob Gas for 100% Load	25411	cmpd	at 100% methane
Heat Rate	13,245	kJ/kW-hr	

Projected Annual Power, Heat and Drilling Revenues to Project

		Power Revenues						Heat Revenues				Drilling Revenues		
Year No.	Years	Gen Power	Energy Cost Escalation	Power Price	Availability	Paras. Use	Revenues	Gen Heat	Heat Price	Revenues	Revenues	Drilling	Drilling Rate	Revenues
		kW	5%	$/kW-h	95%	kW	$US	GJ	$/GJ	$US	$US	(m/yeaar)	$/m	$US
1	1997	1,748	1.00	0.032	95%	55	$ 456,540	76,571	2.43	$ 185,686	$ 450,288	11,250	$ 50	$ 562,500
2	1998	1,989	1.05	0.034	95%	55	$ 547,635	87,133	2.55	$ 221,863	$ 564,918	11,250	$ 50	$ 562,500
3	1999	2,223	1.10	0.036	95%	55	$ 644,474	97,367	2.67	$ 260,317	$ 695,974	11,250	$ 50	$ 562,500
4	2000	2,371	1.16	0.038	95%	55	$ 722,889	103,849	2.81	$ 291,529	$ 818,391	11,250	$ 50	$ 562,500
5	2001	2,371	1.22	0.039	95%	55	$ 759,033	103,849	2.95	$ 306,105	$ 902,276	11,250	$ 50	$ 562,500
6	2002	2,371	1.28	0.041	95%	55	$ 796,985	103,849	3.09	$ 321,410	$ 994,760	11,250	$ 50	$ 562,500
7	2003	2,371	1.34	0.043	95%	55	$ 836,834	103,849	3.25	$ 337,481	$ 1,096,722	11,250	$ 50	$ 562,500
8	2004	2,371	1.41	0.046	95%	55	$ 878,676	103,849	3.41	$ 354,355	$ 1,209,136	11,250	$ 50	$ 562,500
9	2005	2,371	1.48	0.048	95%	55	$ 922,610	103,849	3.58	$ 372,073	$ 1,333,073	11,250	$ 50	$ 562,500
10	2006	2,371	1.55	0.050	95%	55	$ 968,740	103,849	3.76	$ 390,676	$ 1,469,713	11,250	$ 50	$ 562,500

Projected Annual Costs to Project Constant Dollar Except for Real Escalation (Energy)

Year No.	Years	Gas Vol	Energy Cost Escalation	Gas Price	Costs	Facility Op	Drilling Exp	Total
		cm	5%	$/cm	$US	$US	$US	$US
1	1997	7,198,530	1.00	0.022	$ 159,033	$ 283,673	$ 520,600	$ 963,306
2	1998	7,766,578	1.05	0.023	$ 180,162	$ 283,673	$ 520,600	$ 984,435
3	1999	8,373,435	1.10	0.024	$ 203,951	$ 283,673	$ 520,600	$1,008,224
4	2000	8,811,264	1.16	0.026	$ 225,346	$ 283,673	$ 520,600	$1,029,619
5	2001	8,811,264	1.22	0.027	$ 236,614	$ 283,673	$ 520,600	$1,040,886
6	2002	8,811,264	1.28	0.028	$ 248,444	$ 283,673	$ 520,600	$1,052,717
7	2003	8,811,264	1.34	0.030	$ 260,867	$ 283,673	$ 520,600	$1,065,139
8	2004	8,811,264	1.41	0.031	$ 273,910	$ 283,673	$ 520,600	$1,078,183
9	2005	8,811,264	1.48	0.033	$ 287,605	$ 283,673	$ 520,600	$1,091,878
10	2006	8,811,264	1.55	0.034	$ 301,986	$ 283,673	$ 520,600	$1,106,258